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Electricity Generation and Environmental Externalities: Case Studies

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Contents

Tables

Figures

Executive Summary

Electricity constitutes a critical input in sustaining the Nation's economic growth and development and the well-being of its inhabitants.[1] However, there are by-products of electricity production that have an undesirable effect on the environment. Most of these are emissions introduced by the combustion of fossil fuels, which accounts for nearly 70 percent of the total electricity generated in the United States.

The environmental impacts (or damages) caused by these emissions are labeled environmental "externalities." Included in the generic term "externality" are benefits or costs resulting as an unintended byproduct of an economic activity that accrue to someone other than the parties involved in the activity.[2]

This report provides an overview of the economic foundation of externalities, the Federal and State regulatory approaches, and case studies of the impacts of the externality policies adopted by three States.

The Federal Role

Since the 1960s, the United States has witnessed a growing concern over the degradation of the environment. This concern resulted in passage of The National Environmental Policy Act (NEPA) of 1969, the first major Federal initiative to protect the environment and to reduce pollution to non-threatening levels. That effort was followed by major laws that address air and water pollution, solid waste recovery, pesticide and toxic substance regulation, resource conservation, noise abatement, endangered species protection, and other areas of concern.

Federal regulations do not, by themselves, provide a prescription for handling externalities in any systematic manner. Rather, the Federal legislative initiatives seek to restrict (or raise the cost of) using the environment as a repository for emissions. Compliance with most Federal environmental requirements results in added costs to the electric utilities. These costs are reflected in the costs of generating power and in the rates that customers pay for buying electricity. Federal actions may, therefore, be seen as a way of incorporating and internalizing externalities.

Recent Federal regulations strive to shift the focus of environmental regulations to market-based approaches with the intent of containing pollution within specified limits. Voluntary cooperation (without any legislative mandate) is also being encouraged. Within the framework of these approaches, energy efficiency, conservation and demand-side management programs all have a role to play.

The State Role

Treatment of externalities at the State level is far from uniform. Recent reports indicate that slightly over half of State utility commissions currently take environmental externalities into consideration in their resource planning process. Of these, only seven States have specified monetary externality values for designated air emissions from power plants.[3]

Among the States that monetize externality values, the general trend is to incorporate them within the framework of the integrated resource planning (IRP) process, which requires the utilities to evaluate supply- and demand-side options on a consistent basis to meet future demand reliably at the lowest system costs.

The three States (Massachusetts, Wisconsin, and California) that were chosen for the case studies presented in this report incorporate monetized externality values within the IRP process. These States were selected for a detailed study due to their proactive involvement in handling externalities. They had regulations in place for at least a few years so as to allow them to have some effect. The selection of these States also provided a

[1]To meet customer demand in 1993, net electricity generation in the United States totaled nearly 3 trillion kilowatthours using over 30 quadrillion Btus in composite energy resources.

[2]The National Association of Regulatory Utility Commissioners uses a similar definition. See National Association of Regulatory Utility Commissioners, *Environmental Externalities and Electric Utility Regulation* (Washington, DC, September 1993), p. 3.

[3]These States are: California, Massachusetts, Minnesota, Nevada, New York, Oregon, and Wisconsin. Since December 1994, however, Massachusetts no longer uses externality values.

diverse regional mix. The objective was to evaluate the impact externality incorporation had on resources selected to meet future needs.[4]

The analysis presented in this report is based on a review of documents available in the public domain from State public utility commissions and electric utilities. In addition, meetings were held with officials at public utility commissions and with officials of the largest investor-owned utility in each of the three States.

Massachusetts

In December 1989, the Massachusetts Department of Public Utilities (MDPU) directed the electric utilities in the State to include an environmental externality component in their all-resource solicitation criteria. Dollar values were established in 1990 for nitrogen oxides, sulfur dioxide, volatile organic compounds, total suspended particulates, carbon monoxide, carbon dioxide, and other pollutants. The externality values established by the MDPU were to be used in the selection of required resources within the framework of the State's integrated resource management (IRM) process (which treats the supply- and demand-side options on a consistent basis). These values were reaffirmed in November 1992 after a re-investigation.

Since then, the electric utilities in the State have had only one occasion to file their integrated resource management plan with the incorporation of externality values in 1994. From among these, the plan filed by the New England Electric System (which is the largest investor-owned electric utility in the State) provides a good example of the issues considered. These include: forecast of demand and energy use by retail customers; an inventory of existing resources; identification of future resource needs; projections of significant new supply-side commitments and other new resource additions; projection of demand-side resources to be developed; plans for compliance with new environmental requirements; a 2-year plan for implementing the integrated resource plan; and other information required by the State laws.

The utility found that incorporation of monetized externality values in its resource plan merely caused a shift toward natural gas in its plans to acquire capacity. The utility, however, also submitted what it termed a "Green RFP" to permit an accelerated penetration of renewable resources. This submission was prompted by the possibility of more stringent environmental regulations and lower cost of renewables in the future. The utility found it difficult, however, to obtain approval from the three jurisdictions in which it operates—Massachusetts, Rhode Island, and New Hampshire.[5]

Incorporating monetized externality values into the IRM process has been challenged, and the IRM procedures issued in June 1995 do not embody the MDPU's externality policy. The Supreme Judicial Court of the Commonwealth of Massachusetts issued a decision in December 1994 that the decision by the MDPU on the value of environmental externalities was beyond the range of its statutory authority. Thus, externality values will not be used in the future.

Wisconsin

The Wisconsin Public Service Commission (WPSC) asserts that it had an early start with environmental concerns initiated by the enactment of the Wisconsin Environmental Policy Act of 1971 and followed by the Power Plant Siting Law in 1975. The WPSC further contends that plans (called the Advance Plans or APs) submitted by the utilities since 1978 have taken environmental considerations of one kind or another into account.

Currently, the WPSC has set monetized values only for greenhouse gas emissions in the belief that such emissions would become subject to national or international regulations. Utilities in the State are required to use these values in comparing demand-side management programs and in determining the economic cost of resource options in their planning process. Greenhouse gas emissions that are offset by other programs, however, are not monetized. The WPSC's order is limited to the risk of future regulations because there is significant controversy over its authority in the area of air pollution.

Electric utilities in the State of Wisconsin are required to undertake integrated resource planning jointly and submit their plan to the WPSC. The joint plan contains projections of statewide demand for electricity over a 20-year planning horizon together with recommendations with respect to the capacity acquisitions. The plan also addresses major issues such as cost; reliability; efficiency; and health, safety, and environmental effects for meeting the future electrical needs of the State. In addition to the submission of the joint plan, each utility is also required to submit its own individual plan to the

[4]Note that Massachusetts no longer incorporates externality values.

[5]All the projects selected by the utility have since been approved by the three States.

WPSC. Monetized values are used in evaluating demand-side management potential and supply-side resources.

The evaluation by the largest utility in the State, Wisconsin Electric, shows that externality considerations did not lead to any significant changes in the utility's resource acquisition plans. For the utility, natural gas will be the fuel of choice for most of the new capacity in the future. The utility also plans to bring some renewable capacity on line for reasons other than economic cost considerations. In addition, the utility is implementing some voluntary programs to offset its greenhouse gas emissions.

California

The State of California has some of the highest levels of pollution in the country. To alleviate this problem, the State adopted its own Clean Air Act in 1988 to address the unique air quality problems facing the State and to establish procedures to attain ambient air quality standards. The State's environmental regulations address emissions from power plants as well as emissions from other sources like automobiles and industrial facilities.

In its 1990 report, the California Energy Commission (CEC) directed that all costs and emission impacts of compliance with air quality regulations be accounted for in the analysis of the cost-effectiveness of power generation. The CEC specified externality values for five categories of emissions, which include nitrogen oxide, sulfur dioxide, particulate matter, reactive organic gases, and carbon. These externality values are based on the estimates of the marginal cost of the best available control technology. The values differ regionally depending on a region's air quality and the service area.[6]

Monetized externality values were used in the State during the resource planning process in 1993. The CEC noted that externality values have had negligible impact on actual procurement and operations decisions of the utilities. The CEC has subsequently considered marketable permits, environmental performance standards, emission taxes and surcharges, and other methods of evaluating externalities. In the CEC's view, these approaches may permit the "internalization" of externalities. Until this is achieved, its second-best approach is to set standards as interim measures.

The Pacific Gas and Electric Co., the largest investor-owned utility in the State, released its Electric Resource Plan, which indicates that new supply resources will not be required before 2002. In the meantime, its plan calls for upgrades, license extensions, and environmental retrofits. The utility's analysis shows little impact on the mix of resources as a result of externality considerations.

Conclusion

The requirement to incorporate externalities in the resource planning process had negligible impacts on the planned resource mix of the utilities in each of the three States. The scope of demand-side management activities was also largely unaffected by externality considerations.

These findings are not surprising for the following reasons:

- Current low natural gas prices result in natural gas being the fuel of choice to meet the future demand for electricity, with or without the consideration of environmental externalities.
- There has been little need for new capacity.
- Utilities have little experience with renewable technologies (other than hydroelectric power).
- Where utilities operate in more than one State, inter-jurisdictional issues make it difficult for utilities to secure concurrence from all regulatory authorities.

Notwithstanding what is stated above, many Federal policies such as the Clean Air Act have affected utilities' resource plans and choices because the costs of compliance have been fully internalized. The impact of this issue has not been analyzed in this report.

As conditions change, incorporating environmental externalities into the resource planning process may affect the role that energy efficiency or renewable technologies can play in the future. The States, however, continue to reiterate the need to explore new, innovative methods to meet long-term environmental goals. This is especially important since the potential for significant operations and structural changes exists in the electric utility industry, in part due to the enactment of the Energy Policy Act of 1992. The manner in which such goals will be achieved in an increasingly competitive industry environment is not clear at this time.

[6]Externality values specified by the CEC may be modified by the California Public Utilities Commission.

1. Introduction

The electric utility industry in the United States has come a long way from its beginnings more than one hundred years ago when Thomas Edison introduced electricity into New York City.[1] During this period, electricity use has expanded and now constitutes a critical input in sustaining the Nation's economic growth and development and the well-being of its inhabitants.

Net generation from electric utilities amounted to 2,883 billion kilowatthours in 1993.[2] This record power output was produced by the consumption of 30.3 quadrillion Btus of energy resources representing 36 percent of total primary energy consumption in the United States. Coal provided about 57 percent of total net generation, followed by nuclear power at about 21 percent. Hydroelectric power and natural gas each supplied around 9 percent of the total. Petroleum products contributed over 3 percent of the output with other renewable resources accounting for the balance.[3] During the same year, the industry consumed large volumes of fossil fuel—over 800 million tons of coal, nearly 2,700 billion cubic feet of natural gas, and over 160 million barrels of petroleum products—to generate nearly 70 percent of the domestic output of electricity.[4]

To sustain its operating capability at the levels indicated above, the industry owned nearly 700 gigawatts of net summer generating capability in 1993 together with associated transmission and distribution facilities.[5] Significant levels of investment are required to own and operate these facilities, making the electric utility industry the most capital-intensive industry in the country. Its assets in 1993 were approximately three-fourths of a trillion dollars, with aggregate operating revenues of about $200 billion.[6] Taken together, these impressive statistics accord the electric utility industry an important place within the domestic economy.

Yet, the growth of the electric power sector has been a mixed blessing. While electricity has proven itself to be the *sine qua non* of industrialization and societal well-being, byproducts of its production and distribution have an undesirable effect on the environment. Most of these result from the combustion of fossil fuels used in converting thermal energy into electrical energy.[7] Pollutants in the air include nitrogen oxides, sulfur dioxide, traces of heavy metal contaminants, organic pyrolysis compounds, and others.

[1]The term electric utility industry used in this report includes all segments of the industry consisting of investor-owned utilities, public, Federal, and cooperative utilities. Nonutility generators including cogenerators are not included in the statistics reported unless specifically stated. Nonutility sales to utilities represented 6.5 percent of the retail sales of electricity in 1993. For additional information with respect to the industry structure, see Energy Information Administration, *Electric Power Annual 1993* (Washington, DC, December 1994), pp. 1-7.

[2]Energy Information Administration, *Electric Power Annual 1994*, Volume 1, DOE/EIA-0348(94/1) (Washington, DC, July 1995), p. 5.

[3]The net electricity generation increased to 2,911 billion kilowatthours in 1994. Data for 1993, however, have been used since emissions data for 1994 are not yet available.

[4]Energy Information Administration, *Annual Energy Review 1993*, DOE/EIA-0384(93) (Washington, DC, July 1994), p. 237.

[5]There were approximately 192,000 miles of transmission lines in 1993 with more than 13,000 miles planned for addition during the next 10 years. For further details, see North American Electric Reliability Council, *Reliability Assessment 1994-2003* (Princeton, NJ, September 1994), p. 12. For data on generating capability, see *Annual Energy Review 1994,* DOE/EIA-0384(94) (Washington, DC, July 1995), p. 231.

[6]Energy Information Administration, *Financial Statistics of Major U.S. Investor-Owned Electric Utilities 1993*, DOE-EIA-0437(93)/1 (Washington, DC, January 1995) and *Financial Statistics of Major U.S. Publicly Owned Electric Utilities 1993*, DOE-EIA-0437(93)/2 (Washington, DC, February 1995).

[7]The undesirable environmental effects are significantly larger when the impacts are considered with respect to the entirety of the fuel cycle of any specific fuel. Power generation using conventional methods relies on extracting and transporting a fuel, its conversion into electric power, and finally the disposition of residual products including generation facilities. More recent studies take into account the totality of effects of each fuel cycle. As an example, methane (CH_4) emissions from coal mining are considered to be a greenhouse gas contributing to global warming. For further details, see Oak Ridge National Laboratory and Resources for the Future, *U.S.- EC Fuel Cycle Study: Background Document to the Approach and Issues, Report Number 1* (Oak Ridge National Laboratory, Oak Ridge, TN, November 1992).

In addition, fossil fuel combustion also produces carbon dioxide, which absorbs radiant energy, contributing to the greenhouse effect. According to available data, the United States is the world's largest source of energy-related carbon dioxide emissions, accounting for about 22 percent of worldwide emissions in 1990. There is concern that increasing concentrations of greenhouse gases (including carbon dioxide, methane and man-made chloroflurocarbons) may enhance the greenhouse effect and cause global warming.[8] Note that environmental problems associated with nuclear or hydroelectric power generation are of a different dimension not involving the release of greenhouse gases or other pollutants into the atmosphere.

As indicated earlier, fossil fuels currently provide nearly 70 percent of net domestic electricity generation by electric utilities. They contribute to emissions of various gases at significantly high levels into the atmosphere. Estimated emissions during 1993 from fossil-fueled steam-electric generating units were: sulfur dioxide (SO_2), 14.4 million tons; nitrogen oxides (NO_x), 5.8 million tons; and carbon dioxide (CO_2), 1.9 billion tons[9] (Table 1). Other major air emissions are: volatile organic compounds, carbon monoxide, lead, and particulate matter less than 10 microns in diameter (PM10).[10]

There is growing recognition that such emissions adversely impact the environment—locally, nationally, and globally. Economists label these impacts (or damages) environmental "externalities." Included in the generic term "externality" are benefits or costs resulting as an unintended byproduct of an economic activity that accrue to someone other than the parties involved in the activity. As a result, externalities do not enter into the market-pricing calculations of the parties undertaking the activity.

Table 1. Generation and Estimated Emissions from U.S. Electric Utility Fossil-Fueled Steam-Electric Generating Units, 1993

	Net Generation		SO_2 Emissions		NO_x Emissions		CO_2 Emissions	
Fuel	Billion Kilowatthours	Percent of Total[a]	Thousand Short Tons	Percent of Total[a]	Thousand Short Tons	Percent of Total[a]	Thousand Short Tons	Percent of Total[a]
Coal	1,639	83.1	13,844	95.9	5,288	90.4	1,711,673	87.9
Petroleum	96	4.9	583	4.0	136	2.3	84,129	4.3
Gas	237	12.0	1	*	424	7.2	146,584	7.5
Total	**1,973**	**100.0**	**14,428**	**100.0**	**5,848**	**100.0**	**1,942,386**	**100.0**

[a]Total refers to the total quantity for fossil-fired steam-electric units only.
CO_2 = Carbon dioxide.
NO_x = Nitrogen oxide.
SO_2 = Sulfur dioxide.
* = value less than 0.05.
Notes: •Data in this table are with specific reference to fossil-fueled steam-electric generating plants in the United States. •The designation steam-electric excludes gas turbines, combustion turbines, and internal combustion engines. •Emissions estimates are for steam-electric plants 10 megawatts and larger and are based on fuel consumption using average emissions factors as reported in the Environmental Protection Agency's AP-42 Release IV.
Source: Energy Information Administration, *Electric Power Annual 1993*, DOE-EIA/0348(93) (Washington, DC, December 1994), pp. 25-26, 34, 36-37, 76.

[8]Energy Information Administration, *Emissions of Greenhouse Gases in the United States: 1985-1990,* DOE/EIA-0573 (Washington, DC, September 1993), pp. ix -xii. Other greenhouse gases are methane, nitrous oxide and chloroflurocarbons. See "Glossary" for a clarification of the term *greenhouse effect.*

[9]The data include estimates of emissions from steam-electric generating unit plants with a capacity of 10 megawatts and more. Emission estimates from gas turbine and internal combustion units are thus excluded. For further details, see Energy Information Administration, *Electric Power Annual 1993,* DOE/EIA-0348(93) (Washington, DC, December 1994), pp. 71-85.

[10]Council on Environmental Quality (CEQ), *Environmental Quality – 1993,* (Government Printing Office, Washington , DC, April 1995), pp. 435-441. Within the CEQ's accounting framework, as stated in the National Environmental Policy Act of 1969, CO_2 emission statistics are not required. Data on CO_2 emissions for the economy as a whole and for the electricity sector are compiled separately by the Energy Information Administration in terms of the provisions of the Energy Policy Act of 1992. For further details, see Energy Information Administration, *Greenhouse Gases in the United States: 1987-1992*, DOE/EIA-0573 (Washington, DC, November 1994).

In the prevailing rate-setting approach for power generation, only costs associated with providing electricity are taken into account to the exclusion of costs related to the unintended byproducts of producing electricity. Included in this latter category are the costs of impacts on the ecosystem and the environment in general, including human health, that are not fully included in the market price. To the extent that these impacts remain unaccounted for, the cost of power generation remains lower than what it would otherwise be if the cost of burdens imposed on society were also included.

Since the early 1970s, the realization that the environment consists of resources that are scarce and exhaustible has brought about a nexus between the environment and the economy. There has been an interest in "getting the prices right" by including part or all of the excluded costs.[11] Considerations of environmental externalities have thus become increasingly important in the resource planning operations of domestic electric utilities within a regulatory environment.

To reduce the adverse environmental impacts of electricity generation, State and Federal regulatory authorities have initiated several measures. The approaches adopted by the Federal and State authorities, however, differ significantly. The Federal Government passed a significant amount of environmental legislation, such as the Clean Air Act, the Clean Water Act, and the National Environmental Policy Act, which resulted in regulations that mandated compliance. The cost of compliance becomes embedded in the costs of power generation and is thus "internalized." The States' approach is to incorporate a qualitative or quantitative assessment of the environmental externalities remaining after compliance with the Federal regulations in planning for resources within an integrated resource planning framework.

Recent reports indicate that more than half of the State utility commissions currently take environmental externalities into consideration in their resource planning process. In 1990, there were only 17 States with such a requirement.[12] The rationale for this increase in regulatory activity is that conventional electricity generation activities involving the use of fossil fuels impose real and substantial damage to human health and the environment.[13] These effects were not taken into account in planning capacity additions in the past.

This report describes the policies adopted by three State regulatory authorities regarding the treatment of environmental externalities in the utility regulatory process, and evaluates their impact on the resource selection process. The States selected in this study—Massachusetts, Wisconsin, and California—are among the seven that in the past have been actively involved in the quantitative consideration of environmental externalities within the regulatory process and provide a regional diversification.

These three case studies were prepared by the Energy Information Administration (EIA) in response to a request by the International Atomic Energy Agency (IAEA) in Vienna, Austria. The IAEA has been working since the early 1990s toward the objective of providing enhanced capabilities for comparative assessment of different electricity generation options to aid the process of planning and decision-making for the electricity sector in developing countries. Under the aegis of what has become known as the DECADES project, the IAEA is developing a compilation of country-specific case studies for presentation at the International Symposium on Electricity, Health and the Environment in October 1995. It is EIA's intent to provide this report in support of the IAEA's activities.

In addition, this report provides an overview of the economic foundations of externalities within the framework of the theory of welfare economics and describes the major forms of State and Federal regulatory approaches generally used to address environmental impacts of power generation. It also examines the potential future status of externalities within the framework of the integrated resource planning (IRP) process resulting from the amendments to the Public Utility Regulatory Policies Act of 1978 (PURPA) contained in the Energy Policy Act of 1992 (EPACT).

[11]Oak Ridge National Laboratory and Resources for the Future, *Estimating Externalities of Coal Fuel Cycles, Report Number 3* (Oak Ridge National Laboratory, Oak Ridge, TN, September 1994), pp. E1-E22.

[12]National Renewable Energy Laboratory, *Issues and Methods in Incorporating Environmental Externalities into the Integrated Resource Planning Process* (Golden, CO, November 1994), p. 11.

[13]Environmental degradation is also associated with hydroelectric power generation. Its impacts are somewhat different than those of fossil-fueled power plants. Similar considerations apply to generation from nuclear power plants. For further details on this subject, see Oak Ridge National Laboratory and Resources for the Future, *U.S.-EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge National Laboratory, Oak Ridge, TN, report numbers 1 through 8). The first report was published in November 1992. Report numbers 4 through 8, which deal with natural gas, oil, biomass, hydroelectric, and nuclear power generation, are in the process of being published.

2. Economic Foundations of Environmental Externalities: An Overview

To assist the reader in understanding the origins of the economic idea of "externalities," this chapter provides a brief conceptual overview of the term within the framework of the theory of welfare economics and its extension into the environmental field. The background discussion with respect to externalities is extended to electric power generation with a brief reference to overall regulatory approaches.

Economic Foundations of Externalities

Welfare economics may broadly be viewed as a study of the social desirability of alternative arrangements of economic activities and the allocation of resources—that are scarce and have alternative uses—toward a determination of efficient states in which no individual can be made better off without making some other individual worse off.[14] Economic theory on the subject starts with a number of simplifying assumptions (e.g., perfect competition, unrestrained factor mobility, and free trade) to provide a rigorous formulation of conditions under which a state of maximum social welfare (or some variation thereof) becomes attainable.[15]

Among the conditions deemed necessary and sufficient to attain maximum social welfare, the single most critical requirement is the existence of perfect competition in all economic activities in all markets so that the value at the margin of any class of factor (i.e., land, labor, and capital) is the same in all occupations in which it is employed.[16]

Welfare economics essentially aims to "test the efficiency of economic institutions in making use of the productive resources of a community."[17] Achievement of economic efficiency in the allocation of resources is based on the equivalence between marginal costs and prices.[18] Product prices based on this equivalence are

[14]Dr. E.J. Mishan of the London School of Economics defines theoretical welfare economics as "that branch of study which endeavors to formulate propositions by which we may rank, on the scale of better or worse, alternative economic situations open to the society." For a scholarly survey on welfare economics, see E.J. Mishan, "A Survey of Welfare Economics, 1939-1959," *Economic Journal,* Vol. 70 (1960), pp. 197-256. Note that for the most part, welfare economics starts with income distribution as a given and makes no normative investigative attempts in this direction despite significant studies that deal with decentralized mechanisms. Critics further note that the theory does not fully take into account welfare implications that result from growth and development. Despite these criticisms, "the major achievement of welfare economics has been to provide a rigorous framework for what seemed too vague and elusive and to create a measuring rod for what was thought nonmeasurable." For further details, see Kenneth J. Arrow and Tibor Scitovsky, *A.E.A. Readings in Welfare Economics* (Richard D. Irwin, Inc., Homewood, IL, 1969), pp. 6-7.

[15]The earliest exposition on this subject is attributed to the French economist Vilfredo Pareto in his book *Cours d'Economie Politique* published in 1896-1897. Pareto developed the familiar marginal conditions concluding that perfect competition maximizes welfare. English translations of his major economic works are not available. Note that perfect competition is said to exist where the actions of a single buyer or seller / firm have no effect on the price of a product. This requires a large number of buyers and profit-maximizing sellers and the assumption of products being homogenous. In addition, entry and exit for the firms is assumed to be costless, implying mobility of resources and complete knowledge. Product prices under these conditions are equal to marginal costs.

[16]Economists decompose this allocative rule into popular marginal conditions (e.g., marginal conditions for exchange, factor substitution, and product substitution) necessary to maximize social welfare. Note that fulfillment of any one or all of the so-called marginal conditions does not ensure that the welfare of a community is at a maximum, but the nonfulfillment of any one does indicate that welfare is not being maximized since a change in the existing situation can benefit at least one person without harming the position of another person. For a complete discussion of the conditions sufficient and necessary to attain maximum social welfare, see Mark Blaugh, "Economic Theory in Retrospect," Chapter 13, *General Equilibrium and Welfare Economics* (Richard D. Irwin, Inc., Homewood, IL, 1969), pp. 575-614. Also, see C.E. Ferguson, *Microeconomic Theory* (Richard D. Irwin, Inc., Homewood, IL, 1972), pp. 478-502.

[17]Tibor Scitovsky, "A Note on Welfare Propositions in Economics," *A.E.A Readings in Welfare Economics,* Eds. Kenneth J. Arrow and Tibor Scitovsky (Richard D. Irwin, Inc., Homewood, IL, 1969), pp. 390-401.

[18]Development of the welfare theory (and its subsequent refinement) represents a departure from the earlier notions of welfare being the arithmetic sum of individual welfares resting on the concept of cardinally measurable utilities of individuals or households. The current underpinnings of welfare theory (attributable to Vilfredo Pareto in *Cours d'Economie Politique* published in 1896-1897 and *Manuel d'Economie Politique* published in 1906) reflect a radical departure from the notion of cardinality of utility functions and are independent of interpersonal utility comparisons. In addition, Pareto's approach to welfare permitted the separation of efficiency from considerations of equity with respect to the distribution of incomes.

instrumental in the determination of rewards to factors of production (which are land, labor, and capital).

Within the framework of welfare economics, it is argued that demand represents the marginal social valuation or the marginal social benefit derived from an additional unit of a commodity in question. Since the additional units are all priced at marginal cost, the price represents the marginal cost society must incur to have an additional unit produced. The "marginal" argument is extended to include the proposition that social welfare maximization occurs when marginal social costs equal marginal social benefits.[19]

Nonmarket Interdependence and Externalities

Marginal conditions envisaged in the derivation of social welfare maximization are seldom fully met in the real world.[20] As a result, divergences from the idealized equivalence between social costs (which include a valuation for the impacts of externalities in addition to private costs) and private costs (which broadly include the opportunity cost of undertaking an economic activity) and social and private benefits emerge, casting a pall over the grand design of social welfare maximization. Other things being equal, non-market interdependence with its associated attributes of external economies or external diseconomies is identified as the principal causal factor contributing to this divergence.[21] Both the terms—external economies and external diseconomies—have since been abbreviated into what are commonly called "externalities" or the alternative term "spillover effects."[22]

Generally speaking, external economies are realized if the expansion of an industry's output lowers the total cost curve of each firm. Similarly, external diseconomies are realized if the expansion of an industry's output raises the total cost curve of each firm.[23] In both cases, however, market failures cause their emergence (i.e., external economies or diseconomies) such that private costs and social costs differ, leading to economic inefficiency and misallocation of resources in production. These concepts have been instrumental in initially channeling economic analysis into areas that focus on welfare maximization concepts. Subsequent theoretical developments provide tools for performing cost-benefit analyses and their application to issues of environmental policy.[24]

References to the concept of external economies or diseconomies (together with a discussion of welfare economics) appear in the writings of Marshall and Pigou, both English economists.[25] An external economy occurs when an action taken by an economic unit results in uncompensated benefits to other firm(s) such as an increase in its output.[26] As an illustrative example with respect to an external economy, assume

[19]For additional comments on this topic, see C.E. Ferguson, *Microeconomic Theory* (Richard D. Irwin, Inc., Homewood, IL, 1972), pp. 496-497.

[20]Assuming income distribution as a given, conditions necessary and sufficient to ensure optimal allocation of resources can be briefly stated. First, the ratio of marginal utilities of two commodities must be the same for any two customers buying the same commodity. Second, the ratio of the marginal products of the two inputs must be the same for any pair of producers using both inputs. Finally, the marginal social benefit from an extra unit of any commodity should be equal to its marginal social cost. See Edwin Mansfield, *Economics—Principles, Problems and Decision* (W.W. Norton and Co., New York, NY, 1974), pp. 721-735.

[21]Nonmarket interdependence is said to exist when the various production functions and preference functions are interdependent and the activities of one group have either a beneficial or harmful impact on similar activities of another group.

[22]The term "spillover effects" or briefly "spillovers" first appears in Alfred Marshall's writings (*The Principles of Economics*, published in 1890) in connection with a competitive industry's downward sloping supply curve.

[23]External effects may not be unambiguously economies or diseconomies. For further details, see James M. Henderson and Richard E. Quant, *Microeconomic Theory: A Mathematical Approach* (McGraw Hill Book Company, New York, NY, 1980), pp. 143-145, 302-304.

[24]The initial purpose of a cost-benefit analysis is to undertake the appraisal of a project to include all social and financial costs and benefits accruing to the project. Thus, in addition to employing the usual financial analysis approach, undertaking the valuation in money terms of the social or welfare costs and benefits presents special problems. For further details, see Ezra J. Mishan, *Cost-Benefit Analysis* (Praeger Publishers, New York, NY, 1976) for a discussion of the problems in this area.

[25]Alfred Marshall was the first economist to dwell on the subject of external economies and diseconomies. For further details, see Alfred Marshall, *The Principles of Economics* (1890). Pigou, a prize student of Marshall at Cambridge made a clear-cut economic case for a tax (or a subsidy) wherever an external diseconomy (or economy) creates a divergence between private marginal costs and social marginal costs. For further details, see Arthur C. Pigou, *The Economics of Welfare* (Macmillan, 1920). While a number of eminent economists have found the Pigouvian concept and its policy conclusions to be in error, the Pigouvian tax/subsidy doctrine still remains the fountainhead for economic analysis in the area of welfare and its extension to environmental economics. See Ronald Coase, "The Problem of Social Cost," *Economics of the Environment: Selected Readings*, Eds. Robert Dorfman and Nancy S. Dorfman (W.W. Norton and Co., Inc., New York, NY, 1977), pp. 142-171. See also Mark Blaugh, "Economic Theory in Retrospect," Chapter 13, *General Equilibrium and Welfare Economics* (Richard D. Irwin, Inc., Homewood, IL, 1969), pp. 575-614.

[26]Edwin Mansfield, *Micro-Economics: Theory and Applications*, 3rd ed. (W.W. Norton and Co., Inc., New York, NY, 1979), pp. 456-458.

the simultaneous existence of apple-growing and bee-keeping activities in a given region. An increase in the activities of the apple-growing farmers to augment their produce (apples) by an increase in factor utilization (land, labor, or capital) provides an unexpected increase in apple blossoms, which, in turn, tends to increase the production of honey. Here, the apple farmer provides the bee-keeper with additional benefits at no charge. It can thus be argued that the apple-growing farmer receives **less** than the value of his marginal social net product while the bee-keeper gets **more** than the value of his marginal social net product.[27] Consider now the case of an external diseconomy where the output of one production activity adversely affects the production activity of another. The classic example involves a poor widow supporting herself by hand laundry (which is hung outside to dry), and a factory next door emitting smoke that blackens her laundry.[28]

The above two externalities arise due to ownership externalities and focus on production activities. Economic literature also differentiates between pecuniary and technological externalities. Pecuniary externalities result from a change in the prices of some inputs or outputs in the economy. For example, a change in the demand for leather shoes affects the price of leather and hence the welfare of potential leather handbag buyers. In essence, the production function for the handbags remains unchanged.[29] Stated simply, it means that the factor inputs used in producing a product do not change. Such changes do occur, however, in the case of a technological externality. In the case of hand-operated laundry operation, more soap and labor, for example, is required.[30] Thus, technological externalities refer to a more or less direct effect, other than price changes, imposed by one decision unit on another that prevents the efficient functioning of the market mechanism.

In cases of "common-property resources," environmental externalities are concerned primarily with property rights, on the assumption that the source of externalities lies in the absence of fully defined property rights. Take a typical common-property resource like a lake where everyone has fishing rights. Excessive fishing by some reduces the catch for everyone else. A redefinition of property rights or the imposition of some charges may correct the situation. Such prescriptions, however, do not apply to air or water where ownership rights are difficult to establish. Somewhat similar difficulties arise in the case of a resource for which there are competing but conflicting uses, like a body of water that is useful for recreation purposes as well as for dumping city sewage.

It is not necessary to provide a further elaboration in classifying externalities given the subject matter of this report. It is also pertinent to note that a precise definition of the term "externality" beyond its generic description is lacking. Some economists contend that rigorous definitions of "externality" are difficult to provide and that the "definitions of external economies are few and unsatisfactory."[31] More recent attempts to provide a definition continue to prove elusive. Some economists note that they are aware of the implications (of externalities), but attempts to define the notion still fail to capture all its ramifications.[32] More recent extensions of the definition of externalities indicate that the effects of the externality should be appreciable and should fall on a third party or parties that are or were not part of the transaction.[33]

Definitional problems aside, the impacts resulting from the presence of externalities are not in dispute. Market failures attributable to the divergence between social costs/benefits and private costs/benefits lead to an inefficient allocation of resources. Market forces are likely to generate too much of an activity where diseconomies prevail and too little where economies prevail. To counteract these tendencies (which are not reflected in market prices or in valuation of relative goods) or to mitigate their impacts, some degree of

[27]The example cited here has been adopted from the writings of James Meade. See James E. Meade, "External Economies and Diseconomies in a Competitive Situation," in *A.E.A. Readings in Welfare Economics* (Richard D. Irwin, Inc., Homewood, IL, 1969), pp. 185-198.

[28]This example appears in C.E. Ferguson, *Microeconomic Theory* (Richard D. Irwin, Inc., Homewood, IL, 1972), pp. 496-497.

[29]A production function is a mathematical relationship between the output of a firm (or the economy) and the inputs used to produce that output. The relationship can be so written that constant, increasing, or decreasing returns to scale can be exhibited.

[30]This distinction is attributable to Jacob Viner. For a discussion of the concept, see William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy* (Cambridge University Press, New York, NY, 1993), pp. 29-31.

[31]James M. Buchanan and Wm. Craig Stubblebine, "Externality," *A.E.A. Readings in Welfare Economics,* Eds. Kenneth J. Arrow and Tibor Scitovsky (Richard D. Irwin, Inc., Homewood, IL, 1969), pp. 199-212.

[32]William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy* (Cambridge University Press, Cambridge, U.K. 1993), pp. 14-15.

[33]Richard Cornes and Todd Sandler, *The Theory of Externalities, Public Goods and Club Goods* (Cambridge University Press, Cambridge, MA, 1986).

intervention is called for.[34] Policy tools designed to achieve these ends include taxes, user fees, subsidies, and clarification of property rights.[35]

Problem areas still remain. Given that externalities cause distortions in resource use primarily because society fails to pay the price (positive or negative) charged for a good (or a bad), the real problem is how to configure the price to be charged since the normal price mechanism does not usually work. In everyday, normal transactions, prices are generally symmetrical in nature between the supplier and the consumer, but this symmetry is difficult to sustain where externalities are involved.[36] It is thus pointed out that assumptions of asymmetry are necessary to induce efficiency.

Problems resulting from the existence of *pecuniary externality* caused by market interdependence may not be easy to resolve. Consider, for example, the advent of competition (due to passage of the Energy Policy Act of 1992), which is likely to cause such structural changes in the domestic electric utility industry that a number of generating assets (still in operation but with higher costs of production) may have to be treated as *stranded assets*.[37] Such results are due to pecuniary externalities and arise due to changes in some input or output prices in the economy. Even though pecuniary externalities do not cause inefficient allocation of resources under conditions of pure competition, it is necessary to draw attention to this aspect.

Limitations to the theory of welfare economics (with or without the considerations of externalities) also need to be noted. These limitations arise not from the lack of rigor and elegance in the development of its theoretical construct, but rather from the essentially static nature of its conceptualization and with its treatment of income distribution as a given. As a result, the applicability of welfare economics to more dynamic conditions of economic growth and development may be limited.

Environmental Externalities and Electric Power Generation[38]

Discussion in the preceding paragraphs makes it possible to take into account environmental externalities in the context of electric power generation. Power generation involves a process in which the actions of the electricity producer may not be appropriately reflected in the market prices charged for their product. True resource costs should include both the private costs incurred to provide power and the external costs of damage (or deterioration in quality) to the environment caused by power generation. Because of this market failure, the price charged for electric power is lower than it would be if the costs of externalities were internalized, i.e., included in the price charged to consumers for electric power. Consumption of electric power is thus encouraged, leading to a misallocation of resources (in terms of their most efficient use), together with an associated impact on social welfare.

The correct way, in terms of the Pigouvian teachings, is to tax the producers by an amount equal to the magnitude of damages caused. The Pigouvian prescription is embedded in the notion that economic efficiency would be increased by government intervention. However, this simplified version conceals many problems associated with its implementation. Challenges to the Pigouvian concept have since been vocal. Some economists contend that government intervention to internalize should focus on property rights instead of taxing producers and that there may be options that are less expensive (than imposing taxes on producers) which should be explored and used.[39]

[34]Following Pigou's analysis in his book *The Economics of Welfare,* most economists have struggled with a conceptual formulation to mitigate impacts resulting from the presence of externalities. Most prescriptive arrangements postulate that the costs of external damages be recovered. Consensus building continues on who should pay these costs.

[35]*Economic Report of the President, 1994* (U.S. Government Printing Office, Washington, DC, 1994), pp. 179-181. Note that taxes or subsidies are not to be viewed as costs and benefits but rather as a transfer of resources from one segment of the economy to the other.

[36]The notion of symmetry implies that the seller receives the same monetary value (expressed in terms of market price) as the buyer pays. In the case of externalities, factories that emit smoke and pollute the surrounding atmosphere may be subjected to a tax or a subsidy (in the manner suggested by Pigou) to provide the required incentive to the supplier of the externality (the factory in this case) while leaving the nearby residents with a zero price. Thus, the price treatment (required to induce efficiency) loses its intrinsic symmetrical nature. For additional discussion, see William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy* (Cambridge University Press, Cambridge, U.K., 1993), pp. 29-32.

[37]Stranded assets or investments may generally be defined as investments with a cost recovery schedule initially approved by regulatory action that subsequent action has rendered not practically recoverable.

[38]This section focuses on externalities and electric power generation to the exclusion of other segments of the energy sectors. For a further discussion, see Anthony C. Fisher and Michael H. Rothkopf, "Market Failure and Energy Policy: A Rationale for Selective Conservation," *Energy Policy* (August 1989), pp. 397-406.

[39]Ronald H. Coase, "The Problem of Social Cost," *The Journal of Law and Economics* (October 1960), pp. 1-44.

Other economists recommend—in the tradition of Pigou—that externalities associated with power generation be internalized. The term internalizing an externality implies the creation of social conditions where the damages (or benefits) from production and consumption are taken into account by those who produce the effects. These social conditions can be created by government regulation, a tort system, bargaining between private parties, or other policy and institutional arrangements. A taxonomy of alternative methods, including, for example, some form of tradable emission permit system, will be discussed in the next chapter. Note, however, that benefits and damages can exist even when all externalities have been internalized.

Classification of Externalities in Power Generation

Externalities attributable to electric power generation may be classified in the following categories:[40]

- **Air pollutants** including sulfur dioxide, nitrogen oxides, particulates, and heavy metals with impacts on human health, flora and fauna, building materials, and on other social assets like recreation and visibility

- **Greenhouse gases** including carbon dioxide, methane, and chlorofluorocarbons suspected of contributing to global climate change and thus to potential impacts on agriculture and human health

- **Water use and water quality** affected by electricity production, principally through thermal pollution or hydroelectric projects that affect aquatic populations

- **Land use values** affected by power plant sitings and by waste disposal including solid, liquid, and nuclear wastes.

It is possible to provide a different or an enlarged version of externalities' classification based on the choice of criteria used in the process.[41] Note that the types of electric facilities and their functional roles differ considerably from one to the other. Consider, for example, the impacts caused by a hydroelectric power plant in comparison to a pumped storage facility or, for that matter, two identical plants located in areas with different population densities or social infrastructures.

The environmental problems posed by each of these power plants differ and so will their impacts. The task of classifying externalities is further complicated by the absence of a complete checklist of applicable Federal, State, and local environmental laws that relate to all aspects of the electric power industry.[42] For these reasons, a simplified classification scheme is desirable.

The Economists' Approach

Economists' interests focus on the creation of a social arrangement that (in the presence of externalities) can be relied upon to bring about an optimal allocation of resources and thus a maximization of welfare. While some adjustments may be cost free and are a possibility, it is the "common-property resources" that do not lend themselves to simple solutions. The prescription to embody a set of Pigouvian taxes (subsidies) on the generators of externalities to induce them to take into account the full range of social costs (benefits) may not necessarily be an ideal solution that can be universally applied. The general consensus seems to be that no single device such as a tax will eliminate the divergences caused by externalities in private and social costs.[43] Moreover, the application of even well-defined economic principles often faces problems in practice.

Moving away from theory into the realm of policy-making, there are many approaches that have been adopted. Regulatory framework may first involve setting environmental standards or targets for different pollutants and then proceeding to install implementation strategies similar to the provisions of the Clean

[40]Federal Energy Regulatory Commission, *Report on Section 808: Renewable Energy and Energy Conservation Incentives of the Clean Air Act Amendments of 1990* (Washington, DC, December 1992).

[41]A recent publication lists 12 categories of environmental categories impacting on: (i) agricultural crops, timber, and livestock, (ii) catastrophic accidents, (iii) ecosystems and biodiversity, (iv) environmental-cultural icons, (v) global climate change, (vi) human morbidity and mortality, (vii) land use, (viii) materials, (ix) recreational opportunities, (x) regional economic structure, (xi) visibility, and (xii) visual and audio aesthetics. See National Association of Regulatory Utility Commissioners, *Environmental Externalities and Electric Utility Regulation* (Washington, DC, September 1993), p. 10. It is even possible to enlarge this listing if the classification scheme is based on the criteria of impacts.

[42]Congressional Research Service, *Electricity: A New Regulatory Order, A Report Prepared for the Use of the Committee on Energy and Commerce, U.S. House of Representatives* (U.S. Government Printing Office, Washington, DC, 1991), p. CRS-213.

[43]Ronald Coase, "The Problem of Social Cost," *Economics of the Environment: Selected Readings*, Eds. Robert Dorfman and Nancy S. Dorfman (W.W. Norton and Co., New York, 1977), pp. 142-171.

Air Act Amendments of 1990. In some cases, a tax/ subsidy approach could be an option to promote the entry of certain technologies like renewables. These and other approaches are discussed in the next chapter. To conclude, there exists an increasing awareness of the environmental problems caused by power generation. There is, however, a lack of consensus regarding what really constitutes a coherent cost-benefit accounting framework that could facilitate the adoption of some common approach. These problems are discussed elsewhere in this report.

3. Environmental Externalities in Power Generation and the Regulatory Approach

This chapter presents a broad overview of power generation externalities and the environmental regulatory framework in which the electric utilities operate.[44] Major Federal environmental laws that are applicable to power generation are identified and described in this chapter.[45] Against this backdrop, the chapter discusses various approaches—conceptual and operational—that can be taken into account to incorporate environmental externality costs into electric utility resource selection processes. Relative advantages and disadvantages of these approaches are also indicated.

Electric Utilities and the Regulatory Framework

Historically, regulation of electric utilities has entailed a coordinated division of Federal and State jurisdictions with the result that the area of regulatory control exercised by each of them has been delineated.[46] Over time, many events have shaped the evolution of the regulatory format as it currently exists.

A complete discussion of the various nuances of regulatory oversight at the Federal and State levels (including its weaknesses and strengths) is outside the scope of this chapter. State regulation is particularly difficult to summarize even though, in many cases, it is similar to Federal regulation. The principal difference lies in the scale of regulation and the jurisdictional scope exercised by each State regulatory authority. Generally speaking, Federal regulation "followed State regulation and is premised on the need to fill the regulatory vacuum resulting from the constitutional inability of the States to regulate interstate commerce."[47]

To get an overview of the regulatory composition, one possible classificatory scheme is to split the prevailing regulatory design in two separate but interrelated areas, depending on the purely economic or noneconomic character of issues. Economic regulation includes subjects like regulation of financial transactions; rate regulation (including prudence reviews and other issues); regulation of interconnection, wheeling, and transmission; adequate service obligations, including reliability; antitrust issues; and, currently, a myriad of issues confronting the utilities after the passage of the Energy Policy Act of 1992. Noneconomic issues also have several elements. Some of these are: nuclear power plant licensing, spent nuclear fuel and storage, low-level radioactive waste disposal, and environmental regulation that includes clean air, clean water, and others.[48]

The listing above is not fully comprehensive but is merely indicative of the extent of the scope of regulations. Both economic and noneconomic regulatory activities are handled either at the State or at the Federal level. Thus, subjects like rate regulation or prudence hearings, which are singularly economic in nature, fall within the sphere of States' activity, while mergers and acquisitions and/or interstate sales fall

[44]Following general practice, the term "regulation" used in the text includes laws that engender State and Federal regulations. Accordingly, the terms "regulation" and "law" are used interchangeably.

[45]All States play a role in regulating various aspects of the environment (including power generation) within their jurisdictions. However, a centrally codified version of existing State statutes that apply specifically to power generation is not readily available.

[46]Note that despite attempts to delineate jurisdictional areas between the States and the Federal regulatory authorities, differences do occur as in the recent case between the Federal Energy Regulatory Commission and the Public Service Commission of the State of California relative to integrated resource planning. See *Independent Power Report*, "IEP Will Ask FERC To Rehear Ruling Against California's BRPU Auction," March, 1995, pp. 5-6. More recently, a Supreme Court decision expanded States' authority over licensing of hydroelectric projects by broadening their authority under the Clean Water Act. The decision brought forth protests from the supporters of public power. See *Public Power Weekly*, "APPA, others urge Congress to clarify that FERC, not state regulators, has the final say over hydro project," March 6, 1995, p. 3.

[47]For a detailed discussion, refer to U.S. Congress, Committee on Energy and Commerce, *Electricity: A New Regulatory Order?* 102nd Congress, 1st Session, Committee Print 102-F (Government Printing Office, Washington, DC, June 1991), pp. CRS-125 – CRS-235.

[48]Note that the division of regulatory activities into economic and noneconomic compartments is arbitrary since all regulatory actions have financial consequences. The classification stated above has been abstracted from the report cited in the previous footnote.

within the jurisdiction of Federal agencies. The same is true of noneconomic regulations. Environmental regulation (which includes consideration and treatment of environmental externalities) is essentially treated as a major form of noneconomic regulation. Its implementation, however, has significant economic impacts on the industry.

Environmental Externalities in Power Generation

Environmental costs of power generation can be quite significant if the accounting framework is designed to incorporate various costs and benefits with respect to the production and consumption of energy from each fuel source used in power generation. Both upstream and downstream externalities that emerge in the process of securing fuels for power generation, however, are usually not included in the regulatory framework that directly affects electric utilities.

Examples of upstream and downstream externalities can be cited for nearly all conventional fuels, i.e., coal, oil, natural gas, nuclear, and hydroelectric power.[49] Upstream externalities for coal include mining and surface reclamation. Oil and natural gas use have issues associated with drilling, pipelines, and spills.[50] Hydroelectric power is associated with flooding, erosion, and loss of aquatic life in addition to possible curtailment of aesthetics and a loss of habitat for certain species. Downstream externalities are associated with landfills/ash disposal, climate change (or global warming potential), acid rain, transmission lines (electromagnetic fields), and siting. Nuclear power generation has the potential for serious accidents, besides problems with mining, surface reclamation, and waste disposal.[51]

Recently, various studies have taken into account externalities (i.e., damages and benefits) associated with each fuel cycle in power generation. A fuel cycle is the series of physical and chemical processes and activities required to generate electricity from a specific fuel or resource, including primary resource extraction and preparation, transport and storage of resources and materials, processing and conversion, and disposal.[52] As an example, typical environmental interactions attributable to the coal fuel cycle for electricity production are given in Figures 1a, 1b, and 1c.

Environmental costs from the front end of the fuel cycle (mining, milling, drilling, beneficiation, fuel processing, equipment manufacturing, fuel transportation to site, etc.) do not directly devolve on the electric utilities, however. Therefore, impacts (or externalities as stated above) that are a part of the complete fuel-cycle approach are not normally taken into account when considering power generation *per se*. Instead, the current regulatory endeavors are to control some of the externalities directly related with power generation at various plants/sites.[53] Nonenvironmental externality costs and other externalities whose valuation is a problem have additionally been excluded from the prevailing regulatory framework.[54]

Despite the large exclusionary zones as indicated above, there are still significant areas covered by the regulatory treatment of externalities. In the main, these focus on the emissions into the air or water at the electric utilities.

As indicated earlier, the process of burning fossil fuels in power generation brings about emissions that pollute the atmosphere. Among these, the more important gases discharged into the atmosphere are sulfur dioxide and nitrogen oxide. Carbon dioxide releases are

[49]Upstream externalities are those that arise before any fuel source is actually used in power generation. Downstream externalities are associated with fuel consumption including plant siting and related issues (like the possibility of nuclear accidents at nuclear power plants or the sudden bursting of a hydroelectric dam). Both these categories describe the negative impacts of power generation. Positive externalities are also associated with power generation. Included in this category are: impacts on quality of life; enhanced opportunities for employment; increases in productivity, competitiveness, and output; and contributions to national security.

[50]It is important to note that large portions of these damages in the coal, oil, and natural gas cycles are internalized.

[51]For additional details, see Electricity Consumers Resource Council, *Profiles in Electricity Issues: Externalities* (Washington, DC, October 1991), p. 6.

[52]Oak Ridge National Laboratory and Resources for the Future, *U.S.-EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge, TN, November 1992), pp. 1-1 to 1-17.

[53]There is no implication that the externalities associated with production of various fuels are completely ignored. Environmental regulations governing mining and the transportation of fuels do exist as do regulations pertaining to the disposal of mining wastes. To the extent that these activities are not directly under the control of entities that are in the business of power generation, the related regulations have been briefly stated but are not analyzed in this report.

[54]Some examples of nonenvironmental externalities of power generation are balance of payment effects and the national security costs of oil imports. Examples where valuation poses a problem are increases in health care costs, damages to infrastructure in the public domain, risk of nuclear proliferation, and global warming. See Pace University Center for Environmental Legal Studies, *Environmental Costs of Electricity* (Oceana Publications, Inc., New York, NY, 1990), p. 17.

Figure 1a. Environmental Impacts Relative to the Fuel-Cycle Process

CO_2 = Carbon dioxide.
SO_2 = Sulfur dioxide.
NO_x = Nitrogen oxide.
Source: Reproduced from Oak Ridge National Laboratory and Resources for the Future, *U.S.-EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge, TN, November 1992).

Figure 1b. Environmental Impacts Relative to the Fuel-Cycle Process (Continued)

Source: Reproduced from Oak Ridge National Laboratory and Resources for the Future, *U.S.-EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge, TN, November 1992).

Figure 1c. Environmental Impacts Relative to the Fuel-Cycle Process (Continued)

Source: Reproduced from Oak Ridge National Laboratory and Resources for the Future, *U.S.-EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge, TN, November 1992).

considered to contribute to the global warming phenomenon.

Water pollution attributable to power generation includes thermal pollution, adverse impacts on fish populations or aquatic ecosystems, pollution of surface water from coal storage piles, and waste water discharges from the plant.[55]

Federal Approaches to Handling Environmental Externalities

Since the 1960s, the United States has witnessed growing concern over the degradation of the human environment. This concern has been expressed in demands for measures to control or reverse damage and improve the environment. The National Environmental Policy Act of 1969 (NEPA), the first major Federal initiative, laid down new premises for U.S. public policy in pursuing goals to protect the environment and to reduce pollution to nonthreatening levels. This effort was followed by a spate of legislation in other areas to improve the quality of the air we breathe and the water we drink.[56] Recently, the focus on environmental issues has become even sharper due to the potential for adverse climate changes resulting from the impact of human activity.[57]

The determination and implementation of domestic environmental policy can be viewed as a two-step procedure. The first step is to set standards for environmental quality. This is done through a complicated interactive legislative process which establishes the criteria and the standards to be achieved.[58] The next step is for the designated administrative agencies to define and implement the standards by developing regulations that establish procedures and address the steps needed to put the legislation into practice. Disputes concerning what needs to be done and/or how to do it are resolved by judicial intervention, where necessary. Determination of compliance procedures is critical since related costs are passed through to various customer classes.

Responsibilities for environmental control and oversight (including evaluation, monitoring, and implementation of regulations with respect to electric power generation) are distributed among various agencies at the Federal and State levels. Within the Federal Government, while the Environmental Protection Agency (EPA) plays a dominant role, the Nuclear Regulatory Commission (NRC) and the Federal Energy Regulatory Commission (FERC) have technology-specific regulatory roles.[59] Generally speaking, the EPA oversees fossil-fuel generation, the NRC nuclear power plants, and the FERC hydroelectric facilities.

Environmental regulations have a significant impact on power generation since the costs of compliance are passed on to the ratepayers/consumers as part of the ratemaking process. Major Federal environmental laws affecting the electric power industry are summarized in Table 2. The three most significant are:

- <u>The National Environmental Policy Act of 1969</u>, which requires all Federal agencies to undertake the preparation of an environmental impact statement prior to the construction of new nuclear, hydroelectric, and, at times, fossil-fired power plants and high voltage transmission lines

- <u>The Clean Air Act of 1963 as amended in 1970, 1977, and 1990</u>, which regulates the emissions of particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, and lead from fossil-fired power plants

- <u>The Federal Water Pollution Control Act of 1972, amended by the Clean Water Act of 1977</u>, which regulates the use and discharge of water by power plants through required operating permits.

There are other laws, at both the Federal and State levels, that affect—directly or indirectly—the operations

[55]Pace University Center for Environmental Legal Studies, *Environmental Costs of Electricity* (Oceana Publications, Inc., New York, NY, 1990), p. 280.

[56]An alternative view is that the environmental regulation of the electric utility industry serves the dual purpose of minimizing harm to human health and environment and simultaneously securing public consent for necessary development. See Peter Huber, "Electricity and Environment in Search of Regulatory Authority," *Harvard Law Journal* (1987), pp. 1002-1065.

[57]At the Earth Summit in Rio de Janeiro, Brazil, in 1992, the United States joined 160 other countries in signing the *Framework Convention on Climate Change* to address the danger of climate change resulting from increasing concentrations of greenhouse gases, especially carbon dioxide, methane, and nitrous oxides. See U.S. Department of Energy, *The Climate Change Action Plan: Technical Supplement* (Washington, DC, March 1994).

[58]It is also possible that in this "command-and-control" approach, the regulatory authorities may mandate the use of specific control technologies to attain the desired levels of performance.

[59]Other Federal agencies like the Department of the Interior or the Army Corps of Engineers also have a role. This is not discussed here.

Table 2. Major Federal Environmental Laws Affecting Electric Utilities

Legislation	Brief Description of Impacts on Electric Utilities
The Federal Power Act of 1920 (amended by the Electric Consumers Protection Act of 1986)	The Federal Power Act (FPA) provides the Federal Energy Regulatory Commission (FERC) with exclusive authority to license non-Federal hydroelectric power projects on navigable waterways and Federal lands. The Electric Consumers Protection Act amended the FPA in 1986 and required FERC, during its licensing/relicensing activities, to accord equal consideration to environmental aspects of hydroelectric facilities in addition to an evaluation and determination of a number of other factors like power development and public interests. Environmental considerations include the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality.
The Federal Water Power Act of 1920	The Federal Water Power Act authorized the Federal Power Commission, the precursor agency of FERC, to license certain hydroelectric projects that are best adapted to the comprehensive development of a waterway. The FERC's responsibilities in regard to overseeing the development of U.S. water resources were broadened under later legislation including: the Flood Control Act of 1938 and subsequent Flood Control Acts; the River and Harbor Act of 1945 and subsequent River and Harbor Acts; and the Water Resources Planning Act of 1965.
The Fish and Wildlife Coordination Act of 1934 (amended in 1946, 1948, 1958, and 1965)	The Fish and Wildlife Coordination Act requires that a Federal agency licensing a "water resource development project" consult with and give full consideration to the recommendations of the Fish and Wildlife Service under the Department of the Interior. In addition, FERC must include conditions in each license for the protection, mitigation of damage to, and enhancement of fish and wildlife.
The Atomic Energy Act of 1954 (amended by the **Energy Reorganization Act of 1974)**	The Atomic Energy Act (AEA) was first enacted after World War II to give the Federal Government direct control over the development of nuclear power. Congress revised the Act in 1954 to allow for licensing private facilities. The regulation of power plant licensing and siting under the AEA presents significant public policy and legal issues. Environmental and safety considerations are an important element of the licensing process for nuclear power plants. This regulatory responsibility was transferred to the Nuclear Regulatory Commission (NRC) in 1974 when Congress enacted the Energy Reorganization Act, which abolished the Atomic Energy Commission. The NRC has the responsibility for licensing and monitoring nuclear reactors and waste facilities, inspecting nuclear facilities, and investigating nuclear accidents.
The Clean Air Act of 1963 (amended in 1967, 1970, 1977, and 1990)	The 1963 Clean Air Act (CAA), as amended, established a major regulatory system to protect and enhance the Nation's air that is directly applicable to conventional electric power generation facilities. National ambient air quality standards were put into effect for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and lead. Of these, particulate matter, sulfur dioxide, and nitrogen dioxide are emitted in significant quantities by coal-fired electric power plants. The 1990 amendments to the CAA in large part were intended to meet unaddressed or insufficiently addressed problems such as ground level ozone, stratospheric ozone depletion, air toxins, and acid rain, the last of which was directly addressed through the Acid Rain Program.

Table 2. Major Federal Environmental Laws Affecting Electric Utilities (Continued)

Legislation	Brief Description of Impacts on Electric Utilities
The Wild and Scenic Rivers Act of 1968	The Wild and Scenic Rivers Act prohibits FERC from licensing construction of any project under the Federal Power Act "on or directly affecting" a wild and scenic river. In addition, it limits the power of any Federal agency to assist in the construction of any "water resources project" having a "direct and adverse effect on the values" for which the river was designated as wild and scenic.
The National Environmental Policy Act of 1969 (amended in 1975 and 1982)	The National Environmental Policy Act of 1969 (NEPA) requires all Federal agencies to prepare a "detailed statement" for proposed major actions which significantly affect the quality of the human environment. This statement, called an "environmental impact statement (EIS)," must include environmental impacts of the proposed action, alternatives to the proposed action, and any adverse environmental impacts which cannot be avoided should the proposal be implemented. Thus, in effect, where a permit or a license is required for the construction of power plants or associated facilities under Federal law, an EIS is usually necessary. The NEPA does not include all actions taken by electric utilities. It may exclude, for example, the construction of fossil-fuel plants. However, the EIS process may still be triggered if such plants involve Federal approval of any related matter.
The Endangered Species Act of 1973	The Endangered Species Act of 1973 provides a program for the preservation of threatened plants, fish, and wildlife and the habitat in which they are found. The building of dams for hydroelectric power generation can disrupt the ecological environment and, therefore, must adhere to regulations under this Act.
The Safe Drinking Water Act of 1974	The Safe Drinking Water Act of 1974 (SDWA) specifies that any business that has 25 or more employees and is not on a public water system must assure that its source of drinking water complies with certain primary health-related standards.
The Toxic Substances Control Act of 1976	The Toxic Substances Control Act of 1976 (TSCA) requires proper disposal of polychlorinated biphenyls (PCBs) and prohibits their manufacture, processing, distribution in commerce, and use in other than a totally enclosed manner. PCBs were used for many years in electrical equipment, i.e., in the dielectric fluid used in transformers. The Environmental Protection Agency (EPA) subsequently adopted rules governing the marking and disposal of PCBs, and adopted regulations prohibiting and restricting their continued use. Although a number of statutes regulated chemicals after they had become "wastes" or "discharges," no legislation regulated hazardous and toxic substances (other than those used in food or drugs) before they were wastes. TSCA empowers EPA to manage the manufacture and use of toxic substances. TSCA also allows EPA to monitor new or existing chemicals that pose an unreasonable risk to health or the environment.

Table 2. Major Federal Environmental Laws Affecting Electric Utilities (Continued)

Legislation	Brief Description of Impacts on Electric Utilities
The Resource Conservation and Recovery Act of 1976 (extensively amended by the **Hazardous and Solid Waste Amendments of 1984**)	The Resource Conservation and Recovery Act of 1976 is a statute designed to provide "cradle-to-grave" control of hazardous waste by imposing management requirements on generators and transporters of hazardous wastes and upon the owners and operators of treatment, storage, and disposal facilities. The disposal of certain waste by electric utilities may be subject to provisions of this Act. The utilities must comply with a set of standards authorized under this Act, including handling wastes properly and preparing manifests to track the shipment of the waste to treatment, recycling, or disposal facilities. EPA's regulations automatically exempt utility wastes from coal combustion from being considered hazardous wastes.
The Clean Water Act of 1977 (amendment to the **Federal Water Pollution Control Act of 1972**)	States were responsible, before 1970, for setting their own water quality standards. Congress, however, in 1972, established the Federal Water Pollution Control Act. Congress, in 1977, modified the Act to deal with other pollutants, and renamed it the Clean Water Act (CWA). The CWA established a system for setting national effluent standards for pollutant discharges and a national water discharge permit program. The CWA affects various types of electric power facilities in a significant way. Use of large amounts of water for steam to drive turbines, for cooling, and for process uses in conventional power plants and nuclear power plants raises potential water issues. Similarly, the proximity to and dependence of hydroelectric facilities on flowing water as a source of power also raise potential water issues. Thus, electric power facilities can be subject to various obligations including requirements to obtain operating permits and to meet best available technology standards to minimize adverse environmental impacts.
The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (also referred to as **Superfund**)	Electric utilities are among many business establishments that are subject to reporting requirements for spills and other kinds of environmental releases under the Comprehensive Environmental Response, Compensation and Liability Act of 1980. Utilities must report any release of any hazardous substance that exceeds the reportable quantity for that substance (defined in Title 40 of the Code of Federal Regulations) into the air, surface water, groundwater, or soil.
The Nuclear Waste Policy Act of 1982	The Nuclear Waste Policy Act of 1982 (NWPA) specifies that, while the Federal Government has the responsibility to provide for the disposal of high-level radioactive waste and spent nuclear fuel in order to protect public health and safety and the environment, generators and owners of the waste and spent fuel have the primary responsibility to provide and pay for its interim storage. It also establishes procedures for disposal site selection, licensing, construction, closure, decommissioning, interim storage licensing, and retrieval of any spent nuclear fuel for reasons associated with public health and safety, the environment, or the recovery of the economically valuable contents of the spent fuel.

Table 2. Major Federal Environmental Laws Affecting Electric Utilities (Continued)

Legislation	Brief Description of Impacts on Electric Utilities
The Energy Policy Act of 1992	The Energy Policy Act of 1992 (EPACT) contains various environmental provisions with respect to global warming issues. While there are no mandatory requirements affecting electric utilities, voluntary reporting of greenhouse gas emissions and reductions will be used by the Department of Energy (DOE) to develop an inventory of the national aggregate emissions of each greenhouse gas for each calendar year of a baseline period. This inventory will be updated and analyzed annually. EPACT also requires DOE to study and implement water conservation measures at Federal water projects to provide more water for fish and wildlife. In addition, EPACT contains numerous provisions designed to foster development of renewable energy technologies that contribute little to smog, acid rain, or greenhouse gas emissions.
The Wilderness Act of 1964 **The Historic Preservation Act of 1968** **The Water Quality Improvement Act of 1970** **The Coastal Zone Management Act of 1972** **The Federal Land Policy and Management Act of 1976**	Potential hydroelectric power generation projects may be constrained by these miscellaneous laws if certain associated environmental regulations apply.

Note: • Following general practice, the term "regulation" used in this table includes laws that engender Federal regulations. Accordingly, the terms "regulation(s)" and "law(s)" are used interchangeably. • This section is based on information compiled from various documents including *Congressional Quarterly* and the *Environmental Law Reporter* as well as others published by the following organizations: the Environmental Protection Agency, the Congressional Research Service, Government Institutes, Inc., the Environmental and Energy Institute, the Environmental Law Institute, the Council on Environmental Quality, and the Federal Energy Regulatory Commission.

of electric power generation. Certain categories of wastes, such as the sludge from flue gas desulfurization equipment at coal-fired plants, may be subject to the provisions of the Resource Conservation and Recovery Act of 1976 that require treatment of hazardous wastes from "cradle to grave" and set forth a framework for the management of nonhazardous solid wastes. The Endangered Species Act may affect siting or operation of power plants such as wind facilities or hydroelectric plants. The Electric Consumers Protection Act requires FERC to consider specific environmental values in making hydroelectric license determinations. Other regulations like the Surface Mining Control and Reclamation Act of 1977 are directed toward coal mining operations, while the Uranium Mill Tailings Radiation Control Act of 1978 deals with mill tailings left behind during the milling and mining stages of uranium recovery. Disposal of polychlorinated biphenyls is governed by the Toxic Substances Control Act of 1976.

The Energy Policy Act of 1992 (EPACT) contains various environmental provisions addressing global warming issues and reinforcing the authority vested in FERC to require the construction of "fishways" in hydroelectric power facilities. Title XVI of EPACT contains provisions on the subject of global warming including requirements to assess alternative policy mechanisms for addressing emissions of heat-trapping "greenhouse gases," creation of a greenhouse gas inventory (and issuance of guidelines for gathering voluntarily collected data on greenhouse emissions), carrying out an innovative environmental technology transfer program, and development of a least-cost strategy for future national energy plans.

It should be noted that Federal regulations do not by themselves provide a prescription for handling externalities in any systematic manner. Rather, the Federal actions greatly rely on a "command-and-control" system of environmental regulations implicit in the Clean Air Act Amendments prior to 1990 that sought to restrict (or raise the cost of) use of the environment as a repository for emissions. In this approach, the emphasis is on control rather than on prevention. More recently, environmental regulations indicate a shift toward market-based approaches that tend to contain pollution within specified limits.[60]

[60]For additional information, see Energy Information Administration, "Environmental Externalities in Electric Power Markets," *Electric Power Monthly*, to be published in the fall of 1995.

For example, the provisions of the Clean Air Act Amendments of 1990 (CAAA) require the Environmental Protection Agency (EPA) to establish the Acid Rain Program, which in turn requires the utilities to substantially reduce their emissions of sulfur dioxide and nitrogen oxides. To achieve a predetermined level of emissions, the CAAA uses market licenses (allowances) as opposed to regulations that specify actions to be undertaken. Utilities are, therefore, endowed with considerable operational flexibility since it is the total quantity of emissions that matters and a utility can achieve its target level through emission controls, fuel switching, conservation programs, or by buying or trading allowances.[61] Within this market-oriented framework, energy efficiency, conservation programs, or demand-side management programs all have a role to play.

Other areas of Federal regulation also include hydroelectric licensing; water pollution; and nuclear plant construction, operation, maintenance and decommissioning, including disposal of radioactive waste. To the extent that most of these Federal actions result in added costs to the utilities, they may be construed as ways of incorporating and internalizing costs even though not all damages are completely eliminated.[62]

In addition to Federal regulatory requirements, participation in environmental efforts may also be voluntary. Initiatives proposed under the Climate Change Action Plan are designed to voluntarily reduce emissions of greenhouse gases that contribute to global warming.[63] Some efforts by electric utilities are voluntary in nature. Observed results of the voluntary cooperation indicate a noteworthy level of success without any specific legislative authority.[64]

State Approaches to Handling Externalities

Not all States take externality considerations into account. As will be discussed in Chapter 7, slightly over half the States consider externalities, either qualitatively or quantitatively. From among these States, the requirement to include externalities (in the resource selection process) by using monetary values is applicable only in seven States.[65] These States attempt to incorporate the externality costs of power generation. Their undertakings, however, do not aim to achieve the optimal regulation that may become necessary if all stages of a fuel cycle were to be taken into account.[66] Rather, their efforts are limited to possible investment choices that utilities need to make when considering additions to capacity.

"Integrated Resource Planning" (IRP) is the vehicle generally used to evaluate future resource requirements. Within the context of the IRP process, the scope of utility resource planning has broadened significantly from its earlier focus on augmenting primarily supply-side options. Demand-side methods (like conservation and efficiency improvements, load shifting/management) and non-traditional supply options (like renewables, cogeneration, and output from qualifying facilities) all now have to be considered in the process

[61]For a detailed discussion of the compliance strategies for control of emissions, see Energy Information Administration, *Acid Rain Compliance Strategies for the Clean Air Act Amendments of 1990* (Washington, DC, March 1994), pp. 13-39.

[62]The Pacific Northwest Electric Power Planning and Conservation Act of 1980 is different from most of the other Federal legislative enactments. Its statutory requirements stipulate that a cost-effective methodology for determining environmental costs be submitted and that conservation resources be accorded a 10-percent advantage over traditional resources.

[63]The *Climate Change Action Plan* (The Plan) issued by President Clinton on October 9, 1993, provides a road map by which the United States can meet greenhouse gas reduction commitments. The primary objectives of this Plan aim to return U.S. greenhouse gas emissions to 1990 levels by 2000 with cost-effective domestic actions. See U.S. Department of Energy, *The Climate Change Action Plan* (Washington, DC, October 1993). Current analysis indicates that these objectives may not be attainable by the end of this decade.

[64]The "Climate Challenge" program initiated by the Department of Energy (DOE) and electric utilities is a good example of participation by electric utilities in voluntary environmental efforts. On April 20, 1994, the DOE and five organizations representing hundreds of electric utilities executed a memorandum of understanding (MOU) in which the utilities made voluntary commitments to reduce greenhouse gas emissions. The collaborative program envisaged in the MOU is similar to EPA's 33/50 voluntary cooperation program with the industrial sector (initiated in 1991) to reduce releases of toxic chemicals—33 percent by 1992 and 50 percent by 1995. See Sheryl Sturges and Jeffrey Hewitt, "Progress of a Policy Experiment: Climate Challenge Interim Report Card," *Electricity Journal* (January/February 1995), pp. 60-70. The authors contend the utilities have taken the "Climate Challenge" program seriously and that significant results can be expected.

[65]These States are: California, Massachusetts, Minnesota, Nevada, New York, Oregon, and Wisconsin. Massachusetts, however, will not use externality values in the future due to a decision given by the State Supreme Court in December 1994.

[66]A fuel cycle may be defined "as the series of physical and chemical processes and activities that are required to generate electricity from a specific fuel or resource." Based on this definition, the fuel cycle has the following elements: primary resource extraction and preparation, transport and storage of resources and materials, conversion and processing, end-use services, and disposal. See Oak Ridge National Laboratory, *U.S.- EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge, TN, November 1992), pp. 1-1 to 1-17.

of determining how to meet future demand for electricity and capacity. Along with this new focus in comparing supply-side and demand-side management cost options on a consistent basis, an extension of this planning process further includes consideration of environmental externality costs attributable to electricity generation in comparing the cost of the resource options.[67]

Regulators view the requirements that utilities consider externalities in their comparisons of all supply-side and demand-side options as analogous to providing a level playing field to both sources. Accordingly, the approach to incorporating externalities within the IRP process is grounded in the belief that power generation imposes substantial environmental and societal burdens that are not taken into account either in the traditional least-cost planning and resource selection process or by the prevailing regulatory controls. Another compelling argument is the real possibility that environmental controls will tend to become more stringent in the future. Prudence, therefore, dictates that externality considerations be taken into account at the time of resource selection to avert the possibility of incurring significant financial costs at a future date, given the 30- or 40-year life span of power plants.

Regulatory support for including externality considerations in the planning process is further bolstered by the expectation that inclusion (or internalization) of environmental externalities in social costs may accelerate the penetration of renewables and demand-side management options on a competitive basis. In fact, recent developments associated with potential global warming and climate changes may tend to accelerate acceptance of renewable technologies if externality considerations are extended to include all stages of a fuel cycle with respect to a resource being used in power generation.

Identification, valuation, and determination of environmental externality costs represent a set of controversial issues which have not yet been fully resolved. The initial conceptual framework to include externality costs in power generation attempted to encapsulate essentially those externalities (or damages) that could directly be attributed to power generation. As a result, the role of the State regulatory authorities is rather limited in its scope and does not really require the utilities to fully internalize environmental costs in their entirety.[68]

In other States that do not consider externalities, lack of legal authority or lack of agreement on how to go about it are the two principal reasons. Absence of reliable estimates of environmental damages may be another. It is possible that the number of such States and of those that use qualitative assessments may change in the future.

Strategies for Valuation of Externalities

There is a lack of consensus in the literature in adopting a classification scheme that can encompass all approaches currently employed by the States for calculating external costs. This diversity in taxonomical representation is not indicative of fundamental differences in coverage but reflects preferences used to describe more or less the same subject matter.

For example, one study identifies two basic approaches to calculating external costs: "direct damage estimation" and "cost of abatement."[69] Direct damage estimation implies the feasibility of undertaking a monetary

[67]As defined in the Energy Policy Act of 1992, the term "integrated resource planning" means, in the case of an electric utility, a planning and selection process for new energy resources that evaluates the full range of alternatives, including new generating capacity, power purchases, energy conservation and efficiency, cogeneration and district heating and cooling applications, and renewable energy resources, in order to provide adequate and reliable service to the customers at the lowest system cost. The term "system cost" means all direct and quantifiable net costs for an energy resource over its available life including the cost of production, distribution, transportation, utilization, waste management, and environmental compliance.

[68]The term "internalization," although used commonly, remains undefined. One definition of "internalizing an externality" implies the creation of "social conditions where damages (or benefits) from production and consumption are taken into account by those who produce these effects. These social conditions can be created by government regulation, a tort system, bargaining between private parties, or other policy and institutional arrangements. Benefits and damages can exist even when all externalities have been internalized." Another definition states that "internalization of externalities does not mean there are no environmental costs borne outside the utility and its ratepayers. Instead, the utilities and its customers must pay for the environmental resources they consume, just as they pay for concrete, labor and other inputs to the production of electricity." Both these definitions are extensive in their coverage. See Oak Ridge National Laboratory and Resources for the Future, *U.S.- EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge, November 1992), p. xii, and National Association of Regulatory Utility Commissioners, *Environmental Externalities and Electric Regulation* (Washington, DC, September 1993), p. 25.

[69]Lawrence Berkeley Laboratory, Energy and Environment Division, *Comparative Analysis of Monetary Estimates of External Environmental Costs Associated with Combustion of Fossil Fuels, Report # LBL-28313/UC-310* (Berkeley, CA, July 1990), p. 5.

valuation process with respect to the damage caused by a given pollutant. Cost of abatement takes into account the cost of pollution controls for a given pollutant.[70] In both these approaches, the value of reducing each externality is monetized.

Another study identifies three valuation strategies: "direct cost estimation," "indirect cost estimation," and "contingent valuation."[71] Direct cost estimation is similar to the direct damage estimation technique discussed above. The indirect cost estimation approach is used where exact cost identification is a problem and an indirect pricing (or hedonic) approach is used.[72]

The contingent valuation approach utilizes surveys and controlled experiments to ascertain how various attributes are valued. All these methods offer different ways of estimating damages.

It is possible to combine most current approaches into broad generic approaches.[73] In the process, specifics tend to be masked and boundaries begin to overlap. Accordingly, it is preferable to adopt a version that provides more rather than less detail.

Seven main approaches have recently been identified for addressing environmental externalities within the integrated resource planning framework.[74] These are:

- Qualitative Treatment
- Weighting and Ranking
- Cost of Control
- Damage Function
- Percentage Adders
- Monetization by Emission
- Multi-Attribute Tradeoff Analysis.

Qualitative Treatment

A number of State regulatory authorities currently require utilities to adopt some kind of "qualitative" consideration regarding the environmental impacts of resource options without specifying any quantitative or accounting mechanisms.[75] This approach requires environmental impacts to be described and considered when making choices, based on informal and flexible assumptions. The impacts on several factors (with perhaps several elements in each factor) such as health, safety, reliability, environment, and others may be taken into account. The impacts may be described in descriptive terms like no impact, moderate, or significant impact.

The rationale for adopting the above procedure stems from the difficulty of quantifying impacts, especially when there is no agreed upon set of values for adoption. An alternative explanation is the absence of statutory or judicial authority to impose quantification of externalities. These methods, it is maintained, lack specific standards by which to compare options, making it difficult "to assess exactly what effect externalities had on a particular decision, or to predict what effect it (they) will have on the next decision."[76]

Despite its shortcomings, the qualitative approach has the merit of initiating a start with respect to the inclusion of externalities (based purely on application of subjective factors) in the planning process. However, whether the qualitative approach can possibly send the right price signals (to equate private and social costs) remains ambiguous and constitutes its major drawback.

[70]Cost of abatement approach is similar to the valuation methods adopted in another study. See Paul Chernick and Emily Caverhill, "Methods of Valuing Environmental Externalities," *The Electricity Journal* (March 1991), pp. 46-53.

[71]Electric Power Research Institute, *Environmental Externalities: An Overview of Theory and Practice, Report EPRI CU/EN-7294* (Palo Alto, CA, May 1991), p. III-1.

[72]Economists term this approach "shadow pricing." This is a concept applied to situations where the actual prices cannot be charged, or where the actual prices charged do not reflect the real sacrifice made when some activity is pursued. As an example, the cost to society of using an unemployed laborer is zero even though the laborer, if employed, will have to be paid a wage. Alternatively, in periods of excess demand for labor, the shadow price is higher than the wage rate.

[73]The *Special Report on Externalities* released by the National Coal Council in 1992, for example, adopts a somewhat different (but still a broad and generic) classification for establishing externality values.

[74]The classification described here is based on a recent study completed by the National Renewable Energy Laboratory for the U.S. Department of Energy. See National Renewable Energy Laboratory, *Issues and Methods in Incorporating Environmental Externalities into the Integrated Resource Planning Process,* Report No. NREL/TP-461-6684 (Golden, CO, November 1994), pp. 24-35.

[75]Based on a study undertaken by the Consumer Energy Council of America Research Foundation, 17 States have adopted this approach. See Consumer Energy Council of America Research Foundation, *Incorporating Environmental Externalities into Utility Planning* (Washington, DC, July 1993).

[76]Public Service Commission, State of Wisconsin, *Staff Issue Paper: Externalities* (Madison, WI, October 1991), p. 9.

Weighting and Ranking

The "weighting and ranking" approach has been aptly characterized as a hybrid between the qualitative approach and the quantitative approach.[77] The approach recognizes externalities and applies relative scores to competing resources. The impacts can be weighted based on an assessment of their relative-importance, and options can be ranked for a given impact category. By combining the two, a "score" can be derived for each option. These scores (or percentages) can be related to a dollar value for use in the planning process. Thus, monetary values emerge even though a subjective evaluation process is used in the initial stages.[78] Proponents of this approach claim that the use of weighting and ranking offers flexibility as externality values undergo absolute and relative changes over time.[79] In addition, an element of transparency is introduced which facilitates a better understanding of the process involved.

Critics point out that, because the resulting monetary values result from multiple layers of subjectivity, comparisons among impacts or among utilities become confusing. Evaluations of tradeoffs between economic and environmental impacts also become difficult.[80]

Cost of Control

The "cost of control" approach looks at the cost (in monetary terms) imposed by regulatory requirements (current or anticipated) for controlling emissions or other pollutants. An example is the requirement in the Clean Air Act Amendments of 1990 for a reduction in the levels of various pollutants resulting from the use of fossil fuels. The related costs of controlling emissions can be readily observed as a basis for deriving monetized measures and can be viewed as a proxy in a limited sense for damage control costs.

The same approach is also described in the literature under differing labels: the abatement cost approach, the revealed preference approach, and the implied valuation method. Of these, the abatement cost approach comes closest to describing the cost of control approach. This approach starts with the assumption that direct damage costs can never be adequately estimated. If, therefore, regulations are set "efficiently" to equate environmental benefits with abatement costs at the margin, then compliance costs are a proxy for damage costs. Doubts have, however, been expressed concerning the requirement to meet the efficiency criteria. Critics point out that there may be "reasons to believe that environmental regulations may not be set at economically efficient levels."[81] In such cases, abatement cost evaluation is a poor indicator of damages. In addition, this approach may well harm or protect the environment at far higher economic costs than are necessary.

The revealed preference approach is based on the "shadow pricing" concept used by economists. Economic theory uses this concept where actual prices cannot be charged or where the actual prices charged do not reflect the real sacrifice when some activity is pursued, leading to an imputed value. This approach assumes that the regulators' choices embody society's preference for pollution control. As a result, this approach holds that the marginal costs of mitigation, control, or abatement may be used as a proxy for society's willingness to pay. Many studies question this concept and its applicability on the grounds that economic regulation is far from efficient and that the uniform application of marginal costs and benefits ignores variations among regions.

The implied valuation method is very similar to the above approach and starts with the assumption that the cost of required control measures provide a reasonable indication of what society is willing to pay to reduce pollution. For example, if the cost of reducing sulfur dioxide emissions is $2.50/lb, then the value of reductions from alternative sources like conservation or demand-side management should also be worth at least the same amount.[82]

Despite the conceptual problems implicit in employing the implied valuation approach, many regulatory

[77]National Renewable Research Laboratory, *Issues and Methods in Incorporating Environmental Externalities into the Integrated Resource Planning Process* (Golden, CO, November 1994), p. 25.

[78]Public Service Commission, State of Wisconsin, *Staff Issue Paper: Externalities* (Madison, WI, October 1991), p. 10.

[79]State of Connecticut, Department of Public Utility Control, *DPUC Investigation of the External Costs and Benefits Associated with Energy Consumption* (Docket # 92-09-29 of December 30, 1993), p. 25.

[80]Public Service Commission, State of Wisconsin, *Staff Issue Paper: Externalities* (Madison, WI, October 1991), p. 10.

[81]For a detailed evaluation of the abatement cost approach, see Oak Ridge National Laboratory, *U.S.-EC Fuel Cycle Study: Background Document to the Approach and Issues* (Oak Ridge, TN, November 1992), pp. 2-9 and 2-10.

[82]Paul Chernick and Emily Caverhill, "Methods of Valuing Environmental Externalities," *The Electricity Journal,* March 1991, pp. 46-53.

authorities continue to rely on this method. The Massachusetts Department of Public Utilities, for example, maintains that using the implied valuation "is the best available proxy at this time" even though problems with this approach were duly recognized in its proceedings.[83]

Damage Function

In contrast with the approaches described above, the "damage function" has economic theory as its basis. The approach aims to determine the amount individuals are willing to pay to avoid a damage that results from a pollutant or the compensation individuals are willing to accept in lieu of the damages. The first two steps in this approach involve identifying impacts and quantifying them. Next, economic values are assigned to impacts that have been quantified and are aggregated to provide a total impact cost or value.

Use of this approach is the preferred option in the recently completed *U.S.- EC Fuel Cycle Study* for estimating externalities of fuel cycles for the following reasons.[84] First, the approach highlights how technological and locational factors influence residual damage (and benefits). Second, utilization of information about physical and behavioral processes to quantify impacts and residual damages provides an essential scientific building block that could be used elsewhere. Third, the approach identifies gaps in understanding of the problems involved. Finally, pollutant-specific information that becomes available as a result of using this approach is useful for subsequent research, development, and planning.[85]

Computation of damage estimates is more complex than other approaches and requires significant engineering, environmental, and economic data inputs. Data are required to measure source emissions and to convert emissions into impacts, which need to be translated into valuations by using standard economic techniques. Of these, the first step using engineering techniques is perhaps the simplest in some cases. There is, however, no agreed-upon methodology for handling the last two steps. The evaluation of impacts is measurable in some, but not all, cases. Monetizing the impacts is also a problem. Finally, adoption of the damage function approach does not really provide a solution to all the environmental issues nor can it quantify all environmental effects (climate change, biodiversity loss, etc.) when scientific knowledge does not support reliable quantification.

As a result, impact evaluation methods and the economic techniques used to value them continue to remain controversial even though methods to estimate the damages have "gained broader acceptance during the last two decades as theoretical valuation issues have been resolved and the body of literature pertaining to specific applications has grown."[86]

Despite the above drawbacks, the *U.S.- EC Fuel Cycle Study* maintains that the damage function approach used in conjunction with "policy judgments is superior to throwing the entire externality debate open to judgment."[87] The Federal Energy Regulatory Commission (FERC) also records its preference for using this approach even though it fully recognizes the limitations. The FERC analysis states that the "limitations of the damage function approach can be overcome with current and future research, while alternative approaches are subject to inherent flaws that cannot be improved through further research."[88]

Percentage Adders

Operational difficulties implicit in evaluating the externality costs in other approaches explain the use of "percentage adders" in some regulatory jurisdictions. A predetermined fixed percentage is added to (or

[83]Massachusetts Department of Public Utilities (MDPU), *Rules to Implement Integrated Resource Management Practices,* Docket No. 89-239, (Order dated August 30, 1991), p. 83. A subsequent review of this directive by the MDPU in 1992 reiterated adherence to this approach and affirmed that the implied valuation approach "remained the most reasonable basis for public policy."

[84]Oak Ridge National Laboratory and Resources for the Future, *U.S. - EC Fuel Cycle Study: Background Document to the Approaches and Issues* (Oak Ridge, TN, November 1992).

[85]Oak Ridge National Laboratory and Resources for the Future, *Estimating Externalities of Coal Fuel Cycle, Report No. 3* (Oak Ridge, TN, September 1994), pp. 4-22 through 4-24.

[86]Oak Ridge National Laboratory and Resources for the Future, *U.S.- EC Fuel Cycle Study: Background Document to the Approach and Issues*, Report No. ORNL/M-2500 (Oak Ridge, TN, November 1992), pp. 2-2 through 2-5. For an additional discussion of the damage function approach, see RCG/Hagler Bailly, Inc., *New York State Environmental Cost Study* (Boulder, CO, 1994).

[87]Oak Ridge National Laboratory and Resources for the Future, *U.S.- EC Fuel Cycle Study: Background Document to the Approach and Issues*, Report No. ORNL/M-2500 (Oak Ridge, TN, November 1992), pp. 2-2 through 2-5.

[88]Federal Energy Regulatory Commission, *Report on Section 808: Renewable Energy and Energy Conservation Incentives of the Clean Air Act Amendments of 1990* (Washington, DC, November 1992), p. 18.

subtracted from) the avoided cost of a source option.[89] The percent amount to be added may be determined by law, judgment, or estimates of control or damage costs.[90] Note, however, that the adder is used primarily for the purpose of resource selection with respect to the capacity additions needed in the future and is not added to the direct cost of the resource once it is selected.

The use of adders is supported because they are presumed to be large enough to lead to changes in the resource plan by improving the relative cost effectiveness of renewable technologies and demand-side management or conservation programs by implicitly accounting for the full costs of other supply-side options.

As a result, resources are selected "based on the lowest unit costs plus adders."[91] The process could also be used in the noncompetitive bidding resource procurement process. Care is taken to ensure that the value of the adders is not that large so that distortions can be caused. While this situation can be easily avoided, it offers the use of adders an additional advantage that revisions to their use can be made readily as more experience is gained or better insight becomes available.

Proponents would like to extend the applicability of adders not only to the resource selection process but also to dispatch decisions, bulk power transactions, and retail pricing.[92] Including adders and permitting dispatch on a least-cost resource basis would bring the issue of emissions and rates into sharper focus than the application of adders to marginal decisions.[93]

Critics point out that the use of adders does not imply that externalities are being internalized since the only effect is on resource selection.[94] Thus, the adder approach merely "lends itself to the arbitrary manipulation of the resource selection process."[95] It is also pointed out that the inclusion of environmental adders in concert with emissions trading (as envisaged in the Clean Air Act Amendments of 1990) is counter-productive. The effect of adding $1,500/ton for sulfur dioxide emissions could add roughly one cent per kilowatthour to the cost of a coal-fired plant using clean coal (0.8 percent sulfur).[96] "This is half or more of the fuel cost alone, and roughly 15 percent of the total cost of a new plant."[97] These and other considerations of a similar nature lead some other professionals to recommend that it may be time to stop the arbitrary adders, "with their uncertain costs and environmental consequences, and adopt policies that achieve identifiable environmental improvement at the lowest cost to the society."[98]

The debate on the use of adders is far from over and is likely to continue.[99] This is not surprising given the limitations of available options for internalizing externalities and the use of adders, which has grown over time.

Monetization by Emission

The "monetization by emission" approach is essentially a variation of the percentage adder approach. In this approach, valuations of externalities are expressed in terms of dollars per ton of emission or in cents per

[89]This approach is also known as the "avoided cost consideration" approach. See Pace University Center For Legal Studies, *Environmental Costs of Electricity* (Oceana Publications, Inc., New York, 1990), p. 564.

[90]Another variation of this approach is the "monetization by emission" approach discussed next. Note that these two approaches tend to overlap in intent and impact.

[91]Electricity Consumers Resource Council, *Profiles in Electricity Issues: Externality* (Washington, DC, October 1991), p. 10.

[92]Stephen Wiel, "The New Environmental Accounting: A Status Report," *The Electricity Journal* (November 1991), pp. 46-54.

[93]Consumer Energy Council of America Research Foundation, *Incorporating Externalities into Utility Planning* (Washington, DC, July 1993), pp. 100-101.

[94]This position is taken by the Electricity Consumers Resource Council on the grounds that electricity rates may not equal marginal social costs. It may be noted that this argument holds for most other approaches as well. See Electricity Consumers Resource Council, *Profiles in Electricity Issues: Externality* (Washington, DC, October 1991), p. 12.

[95]Electricity Consumers Resource Council, *Profiles in Electricity Issues: Externality* (Washington, DC, October 1991), p. 12.

[96]This is really a part of the "monetization by emission" approach. Instead of adding a percentage amount, externality valuations are expressed in dollars per ton of emissions or in cents per kilowatthour.

[97]Benjamin Hobbs, "Environmental Adders and Emissions Trading, Oil and Water?," *The Electricity Journal*, August/September 1992, pp. 26-34.

[98]Paul Joskow, "Weighing Environmental Externalities: Let's Do it Right!," *The Electricity Journal* (May 1992), pp. 53-67. Dr. Joskow identifies various conceptual and operational problems with the use of adders and favors the use of market-based approaches.

[99]A. Myrick Freeman, et al., "Weighing Environmental Externalities: How to Do it Right," *The Electricity Journal* (August/September 1992), pp. 18-25. Also, Ajay K. Sanghi and Anthony L. Joseph, "Are Externalities Extraneous Under Emissions Cap and Off-set Requirements?," *The Electricity Journal* (January/February 1995), pp. 71-84.

kilowatthour of electricity. The values represent costs imposed on society by residual emissions that remain after compliance. Externality values can be transformed into adjustments to prices to permit a cost comparison of available options.[100] Externality values may also be assigned by regulatory authorities to out-of-State power purchases.

Under this approach, utilities estimate, using the best available information, monetized externality values with respect to designated downstream emissions for inclusion in the costing mechanism. This approach, similar to the "percent adders," provides an easy method to integrate externalities within the framework of the bidding and integrated resource planning processes. This approach has currently been used primarily in the area of air emissions.

In addition to its applicability to the resource option selection processes (as in the case of percentage adders), advocates of this approach desire to broaden its scope by including other areas such as existing resources, repowering, dispatch, and transmission.[101] Opposition to the use of monetized adders at some regulatory level rests on the desire to retain regional economic competitiveness; others would abandon its applicability in view of the provisions of the Clean Air Act Amendments of 1990. In addition, this approach is also subject to some of the same criticism as percentage adders.

Multi-Attribute Tradeoff Analysis

The subjective assessment approach of "multi-attribute tradeoff analysis" has been developed to sidestep the problems associated with estimating monetized values. The approach avoids making an up-front determination (as is done in the case of adders), but attempts to analyze the tradeoff between costs and benefits of different strategies.

The starting point for the multi-attribute tradeoff approach is the identification of important issues and the related development of a set of attributes with which to measure the performance relative to these issues. Concurrent with this phase of activity, multi-option strategies and related uncertainties are identified where each strategy is evaluated across a range of uncertainties to yield a set of scenarios. The scenario analysis provides an attribute database used for comparative analysis of the potential strategies. The scenario analysis is continued until significant improvements in attributes are either unlikely or difficult to analyze. At this point, the decisionmakers or the stakeholders can select a preferred strategy for adoption from among a set of strategies along the tradeoff frontier.

Thus, the tradeoff approach theoretically permits selection of an option from a group of those that are feasible and robust and identifies variations in the resource mix that differ in costs and impacts. Identification of a preferred strategy, or a set of strategies, is then assumed to be an explicit valuation of society's willingness to pay to reduce environmental risks. Existing cost-based planning tools, when used within a multi-attribute framework, are deemed to be adequate to identify lower social-cost-resource strategies and to facilitate their selection under a competitive bidding process.[102]

The main advantage of the tradeoff method is that it forces overall consideration of the effects of various decisions without being constrained by the inaccuracies / rigidities of quantification. While the process encourages experimentation in searching for a low-cost option, lack of a valuation process and application of subjective techniques is perhaps its major drawback.

Other Approaches

The methods or approaches discussed above are those with respect to which State regulatory authorities have jurisdictional control. The cost-of-control and the damage function approaches attempt to value impacts; the others are methods of applying the valuations. In addition to these, there are still some other approaches over which the State regulatory authorities may or may not have complete jurisdictional control. Included in these are:

- Command and Control
- Standards and Targets
- Emission Fees and Fuel Taxes
- Offset or Allowance Trading Policy
- Rate of Return Consideration
- Collaborative Consideration
- Set-Aside Considerations.

[100]Externality valuations are open to review and can be modified where necessary by the regulatory authorities.

[101]California applies monetized emission values to power acquisition as well.

[102]Since 1988, the Massachusetts Institute of Technology Energy Laboratory's Analysis Group for Regional Electricity Analysis (AGREA) has been developing and using the scenario-based multi-attribute (tradeoff) analysis techniques. For a detailed description of the approach see Stephen R. Conners, "Side-Stepping the Adder: Planning for the Least-Social-Cost Electric Service," *Proceedings of the NARUC-DOE Fourth National Conference on Integrated Resource Planning* (Burlington, VT, September 1992).

Command and Control

Directives of the Clean Air Act Amendments prior to 1990 and other similar legislation fall into this category. In these cases, utilities and other power generators can choose from a variety of options to attain a stated objective or goal regarding the attainment of emission levels or other pollutants.

Standards and Targets

This approach is similar to the "command and control" option in which the power generators have options to meet the standards and targets that are prescribed by legislation or directives that require compliance. Reduction of carbon dioxide emissions by the year 2000 to the levels that prevailed in 1990 is a target that various utilities may strive to attain. Standards, on the other hand, may be prescribed for the use of certain types of fuels.

Emission Fees and Fuel Taxes

Under this approach, users of specified fuels may be asked to pay fees (or taxes on fuel) where the fuel's combustion leads to damaging emissions.

Offset or Allowance Trading Policy

"Offsets" are measures designed to mitigate or reduce emissions from other sources in an attempt to compensate for (or offset) higher levels of emission from the designated source(s). As an example, there is a concerted effort to contain and reduce emissions of carbon dioxide to their 1990 level by the year 2000 as part of the Climate Change Action Plan. In some instances, attaining this goal may not be feasible. In such cases, utilities may have the option of initiating activities that reduce levels of carbon dioxide by undertaking other activities like planting trees. Allowance trading can be viewed as another form of offset. With the allocation of allowances under the Clean Air Act Amendments of 1990, utilities that are unable to reduce sulfur dioxide emission levels to specified levels can buy additional allowances. The resulting increase in emissions from these utilities must then be offset, however, by a decrease in emissions from the companies that sold the allowances.

Rate of Return Considerations

Regulatory authorities may award an increased rate of return if certain designated, less polluting technologies are used. In addition, some States may grant a similar advantage to utilities that adopt demand-side management techniques. The intent is to induce industry to use less polluting (or nonpolluting) techniques in generation or to accelerate the promotion of energy efficiency and conservation through active demand-side management.[103]

Collaborative Consideration

The "collaborative consideration" approach involves collaboration among utilities or among various State agencies at the behest of the regulatory authorities to establish externality values and the method of treating them. Six States have been involved in this approach, but tangible results have not yet been visible.[104]

Set-Aside Considerations

The "set-aside consideration" approach may be exercised by State regulatory authorities or mandated by Federal regulations. As an example, the Public Utility Regulatory Policies Act of 1978 required electric utilities to interconnect with and purchase power from facilities designated as "qualifying facilities" by the Federal Energy Regulatory Commission. The legislation further required that utilities pay for such power purchases at approximately their incremental cost of alternative energy or the "avoided cost" of power production.

Assessment of Approaches to Incorporating Externalities

There is not yet a consensus on which approach of the multiple approaches discussed above is best suited to addressing externalities. Environmental impacts of power generation differ regionally and are contingent upon many other factors as well. Levels of generation, location, population densities, and power usage levels all contribute to environmental impacts and work against adoption of a uniform approach. Accordingly, experimentation with varying approaches is likely to continue even though valuation methodologies for estimating damages or costs continue to be characterized

[103]Higher rates of return may be necessary to encourage the implementation of demand-side management (at least in some cases) to compensate for revenue losses.

[104]Richard L. Ottinger, et al., *Environmental Costs of Electricity* (Oceana Publications, Inc., New York, 1990), p. 571.

by unresolved issues. Also, various other externality issues associated with power generation have yet to be actively taken into account. Some of these include valuation of human health risks, transboundary issues, site-specific issues, and the treatment of uncertainties.

There is also a lack of consensus with respect to the incorporation of externality costs in electricity rates. The privately owned segment of the industry (commonly known as investor-owned utilities) asserts that the current incorporation of externality values is confined primarily to the dollar valuation of impacts of one set of externalities from one energy form, i.e., power generation by utilities that are subject to regulation. To the extent other operators and energy sources are excluded from a similar treatment, the approach is unbalanced and works against privately owned utilities and their customers. A full-scale inclusion of externality costs pushes electricity prices upward. This development is likely to affect competitiveness and employment unless the nonutility power producers and alternative fuels are also subjected to similar treatment. Next, it is also pointed out that monetized values increase the cost of supply-side options and thereby increase the cost-effective range for demand-side management options, thus distorting the decision-making process.[105]

This debate on the relevance and applicability of externality values to the resource selection process is likely to continue even as the industry struggles to restructure in the face of increasing competition. Accordingly, whether the attempt to incorporate externalities in the planning process will eventually result in embedding them through a process of internalization into costs of delivered power is difficult to predict.

The next three chapters present the experience of three States—Massachusetts, Wisconsin, and California—that incorporate externalities within the framework of an integrated resource planning process. A description of the processes used in each State is provided. These States were selected for a detailed study due to the extent of their involvement in handling externalities. Besides providing a diverse regional mix, these States had:

- Specific monetary values for externalities
- Regulations in place for at least a few years so as to allow them to have some effect
- Extensive public discourse on the subject, due to public hearings, studies, and other sources of information.

Contemporary studies on externalities focus on methodological issues, estimation procedures, compilation of range of estimates, delineation of scope, problems of applicability, and incorporation techniques. The States selected for the case studies in this report have moved away from these polemics and have attempted to find solutions to these unresolved problems.

[105]Edison Electric Institute, *Environmental Externalities: An Issue Under Critical Review* (Washington, DC, 1994), pp. 1-1 to 1-5.

4. The Commonwealth of Massachusetts Case Study

This chapter presents the experience of the Commonwealth of Massachusetts with respect to incorporation of externalities within the framework of an integrated resource planning process.[106] The information presented in this chapter was gathered from a review of the relevant decisions and orders by the Massachusetts Department of Public Utilities (MDPU).[107] In addition, the largest investor-owned utility in the State, the New England Electric System (NEES), was also contacted and copies of its most recent resource plans were obtained.[108] This evaluation of the impacts of incorporating externalities is based on discussions with the State regulatory authorities and the NEES officials in Massachusetts.[109]

Early History and Procedural Background: Decisions on Externalities

The MDPU opened an investigation into the pricing and ratemaking treatment to be afforded to new generating facilities in February 1986 (Docket No. D.P.U. 86-36-G) with the objective of establishing a regulatory framework that would result in utilities meeting their obligations to serve reliably and at the lowest cost. As a part of this effort, the MDPU attempted to investigate options not only for cost recovery of new investor-owned generating facilities, but also for including all other resources, including nonutility generators, conservation and load management measures, and other demand-side options as a part of a utility's least-cost integrated (supply and demand) planning process. The MDPU sought further comments on the proposed regulatory structure to be designed with a view to eliminate potential conflicts.

The MDPU's Order (Docket No. D.P.U. 86-36-G), issued on December 6, 1989:

- Proposed regulations regarding the procedures by which investor-owned electric utilities' resources are planned, solicited, and procured, and the appropriate ratemaking treatment to be afforded the implementation of such integrated resource management (IRM)

- Established a regulatory review structure with respect to the electric companies' IRM practices, including their procurement of resources with a view to ensure that competitive resource solicitations resulted in the selection of resources that were least cost to society.[110]

On the subject of externalities, the MDPU stipulated (in its order with respect to D.P.U. 86-36-G) that each electric company include an environmental externality component in its all-resource solicitation evaluation criteria. This order required electric utilities to include an environmental externality component in their criteria for evaluating resources offered in response to the companies' solicitations to acquire resources. The scope of the order included solicitations to qualifying facilities, assessments of the cost-effectiveness of conservation and load management programs, power purchase agreements, and any proposed utility generation

[106]Chapters 4, 5, and 6 draw on a recent study undertaken by the Oak Ridge National Laboratory (ORNL) with funding and direction provided by the Energy Information Administration. See Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

[107]The discussion in this section is essentially chronological. It begins with a summary of major decisions made in the late 1980s and the early 1990s that shaped the integrated resource planning process. Within this context, the MDPU initiated actions to incorporate monetized externality values in resource selection. This process continued until the end of 1994. Developments in the State since December 1994, stemming from a key decision by the State's supreme court, are also provided. The MDPU's decision to exclude considerations of externalities in June 1995 has materially changed the way in which externalities will be handled in the State in the future.

[108]New England Electric System (NEES) is a public utility holding company with subsidiaries. "New England Electric(s)," as used in this section, is the name by which the NEES is more commonly known and is understood to encompass the parent and its subsidiaries (unless otherwise stated).

[109]Dr. Suraj P. Kanhouwa of the Energy Information Administration and Dr. Russell Lee of the Oak Ridge National Laboratory participated in discussions with the State regulatory authorities in Massachusetts as well as with the officials of NEES.

[110]Based on Massachusetts D.P.U. 89-239 of August 31, 1990.

capacity. The MDPU also directed companies to include the interaction between new and existing resources in their resource plans. Three different options for including environmental externalities were identified in D.P.U. 86-36-G.[111] However, the MDPU sought comments with respect to the propriety of adopting a uniform externality method.

Thus, among other issues, the MDPU sought comments in two critical areas—the IRM process and the treatment of externalities. To allow the interested parties to discuss the issues raised and permit them to present their positions, the MDPU conducted various technical sessions during 1990. Written comments were invited and were followed by public hearings and receipt of additional comments. Based on a review of these proceedings, the MDPU's final order was issued on August 31, 1990 (D.P.U. 89-239).

MDPU's Rationale for Incorporating Environmental Externalities

The MDPU defined the cost of externalities "as the cost of environmental damages caused by a project or activity for which compensation to the affected parties does not occur, regardless of whether the costs are imposed within Massachusetts borders or elsewhere."[112] The electric utilities were required to include environmental externalities to the fullest extent practicable and quantifiable in their evaluations of conservation and load management programs and other resource options. Such an action encouraged resource developers to consider the value of environmental resources in project proposals and enabled environmentally clean projects to compete fairly.

The Procedural Debate

Regulatory framework designed to achieve the above objectives called for inclusion of environmental externalities through the application of either price or nonprice criteria.[113] The MDPU expressed its willingness to value externalities in dollar terms to be added to the resource price. Alternatively, a "weighting and ranking" approach could be adopted.[114] While there was consensus among the parties concerned to include externalities in the resource selection process, there was disagreement with respect to the method of its implementation. These issues were:

- Using an impact-based versus a technology-based initial ranking system
- Monetizing versus weighting and ranking externality values
- Valuing externalities at the marginal cost of control versus cost of actual damages
- Determining the weight of environmental externalities relative to other project selection criteria
- Extending externality evaluations to site-specific factors
- Extending externality evaluations to include entire fuel-cycle costs
- Extending externality evaluations to include economic and social externalities
- Finalizing the transitional policy for environmental externalities.

The above issues fall into two categories. The first four deal with the valuation and the method of incorporating externalities in the resource selection process and the next three with the scope of externality valuations. The MDPU's assessment, based on comments from various parties, is briefly discussed below.

Regulatory Assessment of Externality Approaches

An Impact-Based Versus a Technology-Based Scoring System

The technology-based scoring system allocates fixed points based on technology types (regardless of the inplace attempts at mitigation).[115] As a result, it takes

[111]These were technology-based, impact-based, and hybrid scoring systems.

[112]The assumption is that the cost of mitigating environmental damages by Federal, State, and local regulations are internalized in a resource developer's production costs and, therefore, in prices bid by developers and electric companies. Any residual damage occurring after compliance with basic environmental regulations is assumed to occur without compensation to affected parties, thereby constituting an external cost. See Massachusetts D.P.U. Docket No. 89-239, p. 51.

[113]Based on Massachusetts D.P.U. Docket No. 89-239, pp. 53-89.

[114]See Chapter 3 for a discussion of this approach.

[115]The words ranking and scoring have been used interchangeably. Note, however, that scoring is necessary for a ranking to be done.

away the incentive to invest in cleaner technology because all projects using the same technology will receive the same score. The impact-based scoring system, which takes into account project-specific environmental impact reductions for given technologies or fuel configurations, more accurately reflects cost differences among projects based on their emission levels. Based on this difference, the MDPU concluded that environmental externality evaluation methodology should take cognizance of the expected environmental impacts that are associated with specific project proposals.

Monetization Versus Weighting and Ranking

Some utilities in Massachusetts supported a weighting and ranking (scoring) scheme with externalities counting for 15 percent of the total score for a resource option. In rejecting this approach, the MDPU supported monetization, contending that the weighted values would still need to be quantified. Its position was that externalities should be monetized to the extent possible, and that such values should be added to direct resource costs for the purpose of evaluating and comparing alternative resource options.[116]

In support of the approach to monetize externalities, the argument is usually one of transparency and ease with which monetized values, i.e., dollar values, can be applied. The unresolved issues (in opposition to this approach) are how to estimate the correct or the appropriate level of monetary values and whether the externality values need to be expressed in monetary terms. The Massachusetts Institute of Technology submitted that there were alternatives to monetization and supported a system-based, multi-attribute evaluation.[117] This approach uses distinct measures of cost, environmental impacts, and reliability in the evaluation of resource portfolios.

Implied Valuation (or Cost of Control) Versus the Value of Environmental Damages

Working from the assumption that the cost of mandated environmental controls is internalized, the MDPU equated the value of environmental externalities with the value of environmental damages from residual emissions. Based on this concept, the MDPU noted that the estimation of environmental externality values enables comparison (on a consistent basis) of the social costs associated with alternative energy resources that differ in prices, emissions, and nonprice characteristics. For such a comparison to be made (to aid the decision-making process), an estimate of environmental damage for each resource becomes necessary. Difficulties in estimating direct damage costs, which may be unknown, lead to a search for alternatives.

Options to search for alternatives are varied. One of the alternatives could include monetization because of its simplified approach and because damage costs are unknown or uncertain.[118] Another alternative is to use the marginal cost of control to reflect the value of environmental impacts implied by the mandated pollution standards.[119]

A method identified by the Massachusetts Division of Energy Resources equates society’s willingness to pay for pollution control with the cost of controlling pollution imposed by regulatory requirements. This method is called the “implied valuation method.” It implies that use of the cost of pollution control provides an estimate or a measure of the price which society is willing to pay to reduce the pollutant. In essence, this method is in the nature of a proxy valuation.[120]

The MDPU still had to decide whether the damage valuation (discussed later in this section) was more appropriate than implied valuation. It opted in favor of the implied valuation method as a reasonable alternative since formulation of comprehensive damage estimates presented many insurmountable problems.

The MDPU adopted monetary values proposed by the Division of Energy Resources using the implied valuation method. These values were to be used by the electric utilities in the State in their submission of IRM plans (Table 3).

Determination of the Scope of Externalities Applications

The MDPU examined whether site-specific and / or fuel-cycle externalities should be included in the IRM resource evaluation process in Massachusetts. It decided

[116]Resource costs in this context are price bids of proposed resources and the avoidable costs of existing and planned resources.

[117]See Chapter 3 for a discussion of the “multi-attribute evaluation” approach.

[118]Note that “monetization” and “damage costs” are not mutually exclusive approaches.

[119]Conceptual amendments to these variations are possible. This statement is, however, based on the Massachusetts D.P.U. Docket No. 89-239.

[120]The “implied valuation method” has been discussed at some length in Chapter 3.

Table 3. Massachusetts Externality Values
(1989 Dollars per Ton)

Pollutant	Value	Basis for Value
Nitrogen oxides (NO_x)	$6,500/ton	Based on the cost of installing selective catalytic reduction on a 10 MW natural gas turbine
Sulfur oxides (SO_x)	$1,500/ton	Based on the cost of installing flue gas scrubbing systems on utility generators[a]
Volatile organic compounds (VOC)	$5,300/ton	Based on a U.S. Office of Technology Assessment study on costs of control technologies for ozone nonattainment areas, and on two studies conducted for the Environmental Protection Agency on the costs of complying with various Clean Air Act targets
Total suspended particulate (TSP) matter	$4,000/ton	Based on the cost of installing an electrostatic precipitator on a high sulfur coal plant with low resistivity fly ash
Carbon monoxide (CO)	$870/ton	The total consists of a $820/ton ambient air quality component (cost of increased oxygenation of gasoline) and a $50/ton greenhouse gas component (the global warming potential of CO relative to CO_2)
Carbon dioxide (CO_2)	$22/ton	In anticipation of CO_2 regulations. Based on the marginal cost of planting trees in a moderate effort to sequester carbon. (Some individuals contend that tree planting costs alone may understate mitigation and control costs since tree planting can offset only a small fraction of CO_2 emissions. But other estimates are much less, say $15/ton.)
Methane (CH_4)	$220/ton	Considering the warming potential relative to CO_2
Nitrous oxide (N_2O)	$3,960/ton	Considering the warming potential relative to CO_2
Chlorofluorocarbons (CFCs)	No value assigned	No clear evidence of whether CFCs cause global climate warming or cooling
Air toxics	No value assigned	Prudent to wait for decision by Environmental Protection Agency
Water use, land use, ash disposal	No value assigned	Impacts are only local or are addressed in the siting process. Considering local siting-specific environmental impacts is not feasible at this point.

[a]The MDPU supported the use of market-based mechanisms. With respect to sulfur dioxide (SO_2) emissions, however, the MDPU noted that the Clean Air Act Amendments (CAAA) may not internalize all of the SO_2-related damages. Its reasoning was that the cap on emissions is only to address SO_2 as a precursor to acid rain, and not all of the health and environmental impacts. The MDPU noted, however, that if a utility obtains allowances under the CAAA or has offsets, then it will not have to apply an externality value to its SO_2 emissions, to the extent that it has allowances or offsets. At least one utility noted, however, that an externality imposed by a ton of SO_x in Massachusetts or New England is not necessarily equal to the marginal price of an allowance in a nationwide trading market.

Note: These values may no longer be used due to a decision by the State's Supreme Court. This is discussed later in this Chapter.

Source: Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

to exclude such considerations in recognition of the additional burdens it would impose in valuation and application.

The MDPU also considered the positive economic and social externalities resulting from power generation. Examples are local job creation and improvement in the quality of life. The MDPU decided, however, to exclude their consideration in the IRM process due to insufficient information.

Summary of MDPU's Findings on Environmental Externalities (D.P.U. 89-239)

- An evaluation system based on project-specific emissions / environmental impacts is preferable to a scoring system that allocates fixed points based on technology types.

- The Massachusetts Institute of Technology Energy Laboratory argued that resource strategies focusing exclusively on improving end-use efficiencies perform poorly in reducing emissions in comparison with resource strategies that balance efficiency improvements in conjunction with supply- and demand-side options. To alleviate these concerns, the MDPU directed electric utilities to optimize ranking of proposals to take into account interactions among resources.

- The MDPU directed that externalities be monetized and that such values be added to direct resource costs when evaluating and comparing alternative energy resources.

- The MDPU concluded that the cost of pollution control estimates that use the implied valuation method to be the best available proxy at the time.[121] Accordingly, the MDPU adopted externality values expressed in dollars per ton of emission that were based on the recommendations of Division of Energy Resources estimates.[122] Table 3 lists these values and the basis for these estimates. Electric utilities under the jurisdiction of the MDPU were directed to use these values in their submissions on various issues in addition to the IRM process.

- The MDPU permitted electric utilities to submit weights of various categories of project selection criteria for review. As a result of this option, the weight of the combined price / externality category could vary among utilities depending on nonprice criteria.[123] The utilities could thus monetize externality values, put them on a consistent basis with price and then allow the relative weights of price / externality and nonprice criteria to vary.[124]

- The MDPU did not favor including local, site-specific impacts in the evaluation process.

- The MDPU directed that priority be placed on estimating environmental externalities that are the direct results of power-plant operations, including all downstream effects, leaving proposals to expand the scope of the regulations to the entire fuel cycle to a later time.

- Although the MDPU took a global view of externalities, it deemed that local job "creation" should ***not*** be counted as a positive externality. In reality, jobs are mostly transfers of individuals moving from one job to another. Granted, not ***all*** jobs are transfer payments, and there may indeed be some social and financial externalities from new employment, but there is insufficient information to generalize.[125] Thus, the MDPU took the position that the benefits of "new" employment should be considered on a case-by-case basis.

Post-1990 Developments

The primary objective of the Massachusetts D.P.U. 89-231 findings was to ensure that the competitive resource solicitations within the framework of the IRM process resulted in the selection of resources that were of least cost to society. Environmental externality considerations were included in this effort to permit a comparison of the environmental impacts of competing resources.

[121]The MDPU issued the order on August 31, 1990.

[122]These estimates are in turn based on a study undertaken by the Tellus Institute. See Stephen Bernow and Donald Marron, "Valuation of Environmental Externalities for Energy Planning and Operations: May 1990 Update," (Tellus Institute, Boston, MA, May 18, 1990).

[123]Examples of nonprice criteria include reliability or system compatibility.

[124]D.P.U. 89-239, pp. 72-76.

[125]For a discussion on this aspect, see Oak Ridge National Laboratory and Resources for the Future, *Estimation of Fuel Cycle Externalities: Analytical Methods and Issues. Vol. 2* (Oak Ridge, TN, July 94), pp. 17-1 through 17-31.

On May 20, 1991, the Massachusetts Electric Company, the retail subsidiary of the New England Electric System and the first company to submit an IRM filing, proposed different externality values to replace all of the MDPU's recommended values listed in Table 3. The MDPU decided to re-investigate whether the externality values established earlier needed revision (by opening D.P.U. Docket No. 91-131).

The MDPU noted that regulations have impacts on ratepayers and considered that if externalities are unaccounted for, then there is a significant risk of future costs to ratepayers and to society. In the view of the MDPU, the resulting risk of more stringent environmental regulation in the future was the most important justification for utilities to position themselves in advance of such regulation. The MDPU also considered externalities to be real costs borne by ratepayers and by the rest of society in the form, for example, of health care expenses. Therefore, in the long run, the MDPU regarded this strategy of accounting for externalities to be more efficient than deferring them. Furthermore, the MDPU did not find evidence that rates would increase greatly as a result of considering externalities, estimating an increase of only 5 percent by the year 2006.

Damage-Cost Estimates of Externalities

Several parties submitted testimony either to support the externality values, change them, or add values for impacts / pollutants not previously monetized (Table 3). The discussion presented here deals only with the "damage valuation" or damage-cost estimation method that was not dealt with in D.P.U. 89-231.[126]

The key conceptual issue confronting the MDPU was to determine whether to rely on the implied valuation method or to adopt the values based on the damage valuation method.[127] The MDPU stated that its externality policy was to allow consideration of the residual emissions of competing resource bids. It acknowledged that the best solution would be to use comprehensive damage costs where feasible. Nonetheless, externality values using the implied valuation method were adopted.

During the deliberations (in connection with D.P.U. 91-131), some of the arguments made in support of adopting the damage valuation method included the following:[128]

- Damage valuation, by measuring damages from pollutants, is conceptually correct since implied valuation estimates provide no defensible basis.

- Damage valuation is based on sufficient scientific information.

- Improvements in damage valuation can be made as knowledge improves.

The adoption of damage valuation was opposed for the following reasons:

- Reliance solely on a theoretically correct approach to provide the best result may not always be correct.

- Damage valuation estimates may not be reasonably credible and defensible.

- Estimating actual damage costs from residual emissions is not an easy task.

- Proponents of the damage valuation method failed to provide a factual showing for their estimates.

- The damage valuation methods and estimates are not accurate or comprehensive and may have the effect of increasing externality values. In its findings, the MDPU noted that monetizing environmental externalities does not eliminate the need for subjective evaluation and that reasonable bounds should be drawn when assessing them. In the case of damage valuation assessment, the

[126]Based on D.P.U. 91-131.

[127]Implied valuation was also referred to as "revealed preference," "marginal cost of control," "highest cost of control," or "cost of control" method. Damage valuation has also been referred to as "marginal benefit of abatement" and "damage cost."

[128]Testimony in support of the damage valuation method was also provided by Dr. Lester Lave and Dr. William Nordhaus. Dr. Lave provided damage-cost estimates for criteria pollutants, i.e., SO_2, TSP, NO_2, volatile organic compounds, and carbon monoxide (CO). Values for human health and all other effects, or "welfare effects," were based on Dr. Lave's professional judgment and the then existing studies. The MDPU pointed out that some of the values recommended by Dr. Lave were incorrect or too high or based on poor data. Dr. Nordhaus' estimates of damage valuation with respect to CO_2 emissions at $2 / ton received support from some (but not all) utilities in the State. The MDPU rejected Dr. Nordhaus' recommendations on grounds that they oversimplified damages, and that uncertainties associated with the results were largely ignored. In conclusion, the MDPU determined that the testimony of Drs. Lave and Nordhaus failed to satisfy the criteria of comprehensiveness and reliability.

MDPU noted that the steps to be followed included:

- Estimating the quantity of emission from the source
- Modelling the chemical transformation and dispersion of the emissions
- Modelling the resultant pollutant exposure to humans, animals, crops, materials, and other affected systems
- Determining the response from those affected by exposure to the pollutant
- Valuing the resulting damage.

All of the above steps are complex and difficult to complete accurately. Valuation is extremely subjective since none of the effects are traded in the market. While conceding the relevance of the damage valuation approach as an ideal, the MDPU still decided against its adoption and lent its support to continuing the application of the implied valuation method.[129] Stated differently, the MDPU reaffirmed its commitment to the implied valuation approach. The MDPU did not, therefore, set new values for incorporation in the resource selection process.

Treatment of Other Pollutants

In addition to pollutants previously assigned values by the MDPU, several other issues were taken up during the proceedings initiated under D.P.U. Docket No. 91-131. Externality values for specific pollutants (like sulfur oxides, nitrogen oxides, volatile organic compounds, total suspended particulates, carbon monoxide, and greenhouse gases) that had been assigned by the MDPU (Table 3) were retained. The MDPU also looked into impacts that were not assigned values in D.P.U. 89-231. Included in this category were chlorofluorocarbons, air toxics, water use, land use, and ash disposal. The MDPU stated that it would prefer to wait for further information on the subject of air toxics (expected to become available from a special study of this topic under provisions of the Clean Air Act Amendments of 1990). On other issues, the MDPU did not initiate any new actions either because there was inadequate evidence or because the impacts were damaging.

Incorporation of Externality Values Within the IRM Process

The integrated resource management process in the Commonwealth of Massachusetts is a four-phase process. Phase I involves a company's submittal of the draft initial filing and its review by the MDPU. The IRM regulations require that the company's (or the utility's) initial filing contain its demand forecast, resource inventory, evaluation of resource need, evaluation of resource potential, resource solicitation request for proposals (RFPs), and initial resource portfolio. Phase II comprises the utility's resource solicitation process when it issues an RFP approved by the MDPU. In Phase III, the MDPU reviews / evaluates the resource mix submitted by the utility together with a list of the proposed awards of contracts with respect to the resources to be acquired. Finally, in Phase IV, the MDPU reviews and approves contracts provided by the utility that resulted from the resource solicitation.

All electric utilities in the State are required to incorporate monetized externality values within the framework of the IRM process so that both supply- and demand-side resources can be compared on a consistent basis and so that electric power can be provided at the least societal cost.[130] The IRM regulations require that a utility publicize its draft initial filing to notify all interested parties, hold technical sessions to clarify plan details, and establish procedures for exchange of required information. The intent is for the utility to reach an agreement with all interested parties on its draft initial filing before its review by the regulatory authorities. Areas where differences exist need to be indicated. In other words, to facilitate its regulatory review, the regulations require that the electric company negotiate a settlement, to the extent possible, among the parties to a proceeding.

[129] With the recent completion of major damage-cost studies, however, these criticisms are considerably muted. These studies constitute an order-of-magnitude improvement in the state of the art in damage-cost valuation. For an extensive discussion of this subject, refer to Oak Ridge National Laboratory and Resources for the Future, *Estimating Externalities of Coal Fuel Cycles, Report # 3* (Oak Ridge, TN, September 1994).

[130] This requirement is no longer operative as a result of the Massachusetts Supreme Court decision in December 1994. In fact, the future of externality considerations in the State is extremely uncertain.

Resource Planning by the New England Electric System (NEES) Companies: An Overview[131]

New England Electric System (NEES) is a public utility holding company and the largest investor-owned utility in the Commonwealth of Massachusetts. Its retail subsidiaries include Massachusetts Electric Company, the Narragansett Electric Company, and Granite State Electric Company and its wholesale generation and transmission subsidiaries, the New England Power Company and Narragansett Energy Resource Company. In addition, NEES has three electric transmission companies, as well as international operations, a management consulting company, and an electric service company. The NEES operates in three States: Massachusetts, New Hampshire, and Rhode Island. It is, therefore, under the jurisdiction of regulatory authorities in these States.

The New England Electric companies submitted their first NEESPLAN in 1979 followed by a second, NEESPLAN2, in 1985. The second plan emphasized integrated supply-side and demand-side least-cost planning to meet demand. The NEESPLAN3, submitted in 1991, took into account growing environmental concerns and increasing cost pressures. In 1993, the NEES companies and the regulatory commissions in Massachusetts, New Hampshire, and Rhode Island implemented a new approach to regional regulation of the resource planning process in terms of which the NEES prepares a 15-year system-wide integrated resource plan every 2 years. Finally, NEESPLAN4, based on the procedural requirements discussed above and finalized late in 1993, was submitted to the MDPU in June 1994.

Underlying Approach in NEESPLAN4

The NEESPLAN4 is an attempt to reconcile the pressures of increasing competition with the demands for environmental improvement.[132] The objectives of the plan are to achieve the following:[133]

- Develop approaches to provide electric service in a more environmentally sustainable manner
- Meet customers' increasing expectations in areas of cost and service
- Assure that services provided by NEES are valuable in an increasingly competitive electric market.

In addition, the NEES aims to remain flexible in resource planning by avoiding the problem of investments becoming "stranded." To encapsulate these themes in its plan and to meet potential future challenges resolutely, NEES took several steps. Critical among these was its collaboration with the Conservation Law Foundation in formulating NEESPLAN4. Next was the adoption of the "options theory," a form of analysis that quantifies the value of flexibility in specific resource alternatives. NEESPLAN4 contains the following principal components:[134]

- Demand forecasts with and without incremental demand-side management (DSM) impacts for system energy requirements
- Resource inventory consisting of existing and planned resources for which commitments have been made
- Identification of future resource needs by application of a probability methodology
- A projection of significant new supply-side commitments and other new resource additions
- A projection of demand-side resources to be developed
- Plans for compliance with new environmental requirements
- A 2-year plan for implementing the integrated resource plan
- Any other information required by State law.

The Planning Methodology

In preparing this plan, the NEES companies first generate a long-term forecast by including economic

[131]The term NEESPLAN signifies the IRM plan submitted by NEES to MDPU and other regulatory agencies.

[132]Based on its projection, NEES maintains that no new capacity will be required until 2002.

[133]Based on NEESPLAN4 documentation as submitted to the MDPU.

[134]NEES companies have developed an approach to regional regulation of their resource planning process due to its operation in three States: Massachusetts, New Hampshire, and Rhode Island. In terms of a memorandum of understanding (MOU), a system-wide integrated resource plan that complies with the separate requirements of each State regulatory authority is prepared every 2 years with a 15-year horizon for submission to the three States.

variables and other system characteristics. Residential and commercial sectors are modelled using an end-use approach. Industrial sales are forecasted using an econometric approach. Company-sponsored demand-side management activity was initially excluded.[135]

System peaks are developed by allocating annual energy to months, days, and hours of the year. System costs are developed by including capital costs, operations and maintenance costs, fuel costs, customer costs associated with demand-side management programs, and the various environmental costs of candidate resource plans. The attempt is to keep prices as low as possible (consistent with reliability) during the planning horizon.

Environmental Considerations

NEESPLAN4 is predicated on compliance with existing Federal, State, and local regulations. Steps currently being taken and those planned for the future to meet provisions of the Clean Air Act Amendments are detailed.

In addition, several other potential issues likely to emerge in the area of air quality requirements are also taken into account. Significant items included in this category are hazardous air pollutants, reductions in nitrogen oxide emissions beyond 1995, and greenhouse gas emissions. Based on these considerations, a range of resource strategies is evaluated against several scenarios to ensure that the "resource plan recommendations would have sufficient flexibility to adopt a broad range of possible outcomes."[136]

All resource plans are also expected to comply with existing regulatory requirements. For eight specific air pollutants, emissions are projected based on an "own-load" dispatch. Emissions with respect to carbon dioxide, sulfur dioxide, and nitrogen oxides in 2000 are compared against stated goals to be achieved. Finally, the system emissions are monetized using values established by the MDPU.[137]

Areas of uncertainty, however, remain. Environmental regulations are expected to be more stringent in the future. The cost of compliance is not known and ranks high on the list of uncertainties. The plan examines environmental uncertainties in depth (Table 4). For each environmental impact, there is an indication of the probable cause of events and the related cost estimates. Next is the possibility that not all resources that are currently in use would continue to be in operation in the face of changes in environmental regulations. To confront these emerging issues, the NEES companies have initiated several studies to examine cost and technical data of various technologies that may be needed to meet stricter environmental requirements.[138]

NEESPLAN4 embraces a novel approach to account for the uncertainties. It uses the application of what the company calls an "options theory." It is a form of analysis that "quantifies the value of flexibility in specific resource alternatives." Its operational impact in resource planning is to place greater reliance on small-scale, short lead time projects that incorporate buyout and termination provisions.[139]

Environmental Initiatives by NEES

As indicated earlier, NEESPLAN4 was drafted in collaboration with the Conservation Law Foundation (CLF). As a part of the planning process, the NEES companies have set for themselves the goal of developing approaches to provide electric service in an environmentally sustainable manner. Pursuing renewable energy projects is designed to meet this goal partially.[140]

[135]For planning purposes, future demand-side management impacts are treated as a supply-side resource.

[136]New England Electric System Companies, *Integrated Least Cost Resource Plan for the Fifteen Year Period 1994-2008, Vol. III,* June 1994, p. 244.

[137]The goal set in NEESPLAN4 is to reduce emissions during the 1990-2000 period as follows: carbon dioxide—20 percent, sulfur dioxide—60 percent, nitrogen oxide—60 percent. See New England Electric System Companies, *Integrated Least Cost Resource Plan for the Fifteen Year Period 1994-2008, Vol. III,* June 1994, p. 309.

[138]New England Electric System Companies, *Integrated Least Cost Resource Plan for the Fifteen Year Period 1994-2008, Vol. IV,* June 1994, p. 347.

[139]The general strategy of the options theory is to manage company's resources as a portfolio of options. In this approach, resource options are used as "capacity insurance" to cover higher-than-expected growth or earlier-than-anticipated retirements. If the expanded growth does not materialize, then the options will not be exercised, and retiring units will not be replaced. The concept is based on the "Options Theory," which deals with the subject of irreversible decisions that are made under uncertainty. See Avinash Dixit and Robert Pindyck, *Investments Under Uncertainty* (Princeton University Press, Princeton, NJ, 1994). A brief summary of this approach is also provided in the plan submitted by the NEES companies.

[140]Other options include stabilizing greenhouse gas emissions, reducing emissions from existing fossil-fuel plants, accounting for and reducing all wastes, and maximizing efficiency of NEES' operations and those of its customers.

With a view to meeting the above goal, the New England Electric System companies have also undertaken additional environmental initiatives to reflect their commitment to reduce the adverse environmental impacts of power generation by planning to use generation technologies that reduce emissions. The companies' renewable energy initiative, "Green RFP," solicited bids from projects using renewable technologies. The solicitation sought for 200,000 MWh annually or about 45 MW operating at 50 percent capacity scheduled to be in operation by 1997.

The companies received 41 bids, totaling about 1.4 million MWh (Table 5). These bids represented all of the major renewable energy technologies and presented projects that were located in all six New England States and Canada. These bids for the projects were evaluated and those projects that had the characteristics necessary to provide the maximum value to the customers (and also had the highest level of feasibility) were chosen from among each renewable technology group. Based on this criteria, seven projects for 36 MW were selected (Table 6).[141]

In performing the economic analysis of the projects, the companies compared the projected costs of these projects with their future forecasted avoided cost.[142] The companies also tested the renewable projects against externality values as adopted by the MDPU.[143] In addition, varying hypothetical values for carbon dioxide emissions were also taken into account. The effect of carbon dioxide adders was taken into account (Table 7).[144] The companies also considered raising fuel prices by 1 to 2 percent above those assumed in their original forecast.

In the aggregate, the expected costs of "Green RFP" projects over their contract lives exceed the companies' projected avoided cost on a present value basis (Table 6).[145] The table also shows the comparative costs of each project. The companies, however, noted that individual project economics would change if environmental externalities were included in the assessment. More specifically, the expected costs of the seven projected renewable energy contracts would be $53.5 million below the companies' projected costs on a present value basis.[146]

Since the NEES companies operate in three States, project contracts require the approval of utility commissions in all of the three States. The MDPU initially approved six of the seven projects on the basis

Table 5. Number and Available Annual Electrical Energy Output of Projects Bid by New England Electric System Companies on the Green RFP (by Type)

Type of Project	Number of Bids Received	Total Available Annual Electrical Energy Output (thousands of MWh)
Biomass	7	659
Hydroelectric	7	28
Landfill Gas	10	200
Solar	4	34
Wind	7	209
Municipal Solid Waste	1	40
Other	5	210
Total	41	1,380

Source: New England Electric System Companies (Granite State Electric Co., Massachusetts Electric Co., and the Narragansett Electric Co.), *Request for Approval of Contracts Executed as Part of Companies' Renewable Resource Initiative, Volume 2: Testimony and Exhibits*, submitted August 1993 to the Massachusetts, New Hampshire, and Rhode Island Public Utilities Commissions, pp. 11-12.

[141]Note that NEES selected projects for 36 MW even though it was initially planning to seek 45 MW of capacity.

[142]The avoided costs were for the year 2001 since NEES does not need any new capacity prior to 2002.

[143]Carbon dioxide values of $2 per ton, $10 per ton, and $24 per ton were used.

[144]The economics of all projects (considered by the NEES companies in their Green RFP) benefit from the adders since the net carbon dioxide equivalent emissions are either zero or negative.

[145]The differences in 1993 and 1994 estimates result from a renegotiation of some of the contracts at a lower price.

[146]Based on the testimony of Mr. Michael E. Hachey before the MDPU in September 1994.

Table 6. Summary of Project Costs Versus Avoided Costs

Project	Energy Source	Net MW	Original Filing Cumulative Present Worth 1993 (million dollars)			Current Filing Cumulative Present Worth 1994 (million dollars)		
			Total Contract Payments	Avoided Costs	Costs Above Avoided Costs	Total Contract Payments	Avoided Costs	Costs Above Avoided Costs
Kenetech Windpower[a] . .	Wind	20.0	43.7	26.9	16.8	38.5	25.8	12.7
Shirley	Municipal Solid Waste	5.9	18.2	16.3	1.9	18.0	15.4	2.6
Johnston	Waste Heat	2.0	7.8	5.9	1.9	7.6	5.6	2.0
Plainville	Landfill Gas	3.0	11.0	9.5	1.5	9.2	9.2	0.0
Nashua	Landfill Gas	1.5	5.6	4.4	1.2	4.1	4.1	0.0
Randolph	Landfill Gas	2.6	12.6	10.0	2.6	10.3	10.3	0.0
Barre	Landfill Gas	1.0	4.4	3.3	1.1	4.5	3.0	1.5
Total		**36.0**	**103.3**	**76.3**	**27.0**	**92.2**	**73.4**	**18.8**

[a]The name of the contractor was changed from U.S. Windpower to Kenetech Windpower in 1994.

Source: New England Electric System, *Request for Approval of Contracts Executed As Part of Companies' Renewable Resource Initiative*, resubmitted to the Massachusetts Department of Public Utilities, September 1994, p. 18.

of their cost effectiveness. After renegotiation of contract costs, the other States have also approved the proposal. In effect, all projects have been approved.

The price impacts of proposed renewable acquisitions are expected to be minor. Ratepayers in Massachusetts will pay a real levelized cost premium of 0.006 cents/kWh. Rhode Island customers will pay nothing above projected avoided costs, on a 1994 dollar net present value basis, and the New Hampshire customers would pay 3 percent above avoided costs or 0.005 cent/kWh real levelized premium.[147]

Externality Considerations and New England Electric's Projected Resource Mix

New England Electric companies' existing resources total 5,610 MW (Table 8). In "The Resource Need Evaluation," the NEES companies stated that they will have sufficient capacity to meet their load and required reserve margins until 2002.

Generic resource additions during the 2003-2013 period total 3,144 MW. The New England Electric companies plan to build natural gas turbine units for a total of 1,507 MW to meet the peak-load demand. Of the remaining 1,637 MW required to meet the baseload demand, gas-fired combined cycle units account for the 1,355 MW, with coal accounting for the balance of 282 MW. Natural gas thus emerges as the fuel of choice in NEESPLAN4.

The companies are concerned about this over-reliance on one single fuel and will continue to evaluate the alternatives available. In addition, the focus on renewables and attempts to reduce greenhouse gases will continue. Improvements in technology to reduce emissions, as well as the push toward demand-side management programs, will continue to be implemented.

Overall, the incorporation of monetized externality values in resource planning may at best be viewed as a shift toward natural gas. Renewable penetration—based on the Green RFP—may be viewed as positive, but the cost benefits accrue only if externality values are internalized. It would thus be correct to say that externality values had no effect on the makeup of the implementation of NEESPLAN4.

[147]Based on submissions filed by the New England Electric companies before the State regulatory authorities.

Table 7. Impact of Carbon Adder on Projects Beginning in 1994

Project	Technology Type	\$2/Ton CO_2-Equivalent A ¢/kwh (1993 RLP)	\$2/Ton CO_2-Equivalent B ¢/kwh (1993 RLP)	\$2/Ton CO_2-Equivalent C 1993 (million dollars)	\$10/Ton CO_2-Equivalent A ¢/kwh (1993 RLP)	\$10/Ton CO_2-Equivalent B ¢/kwh (1993 RLP)	\$10/Ton CO_2-Equivalent C 1993 (million dollars)	\$24/Ton CO_2-Equivalent A ¢/kwh (1993 RLP)	\$24/Ton CO_2-Equivalent B ¢/kwh (1993 RLP)	\$24/Ton CO_2-Equivalent C 1993 (million dollars)
Kenetech Windpower[a] . . .	Wind	0	(0.12)	16.0	0	(0.59)	12.7	0	(1.42)	7.1
Shirley	MSW	(0.14)	(0.26)	(0.6)	(0.72)	(1.32)	(3.7)	(1.73)	(3.16)	(11.2)
Johnston	Waste heat	0	(0.13)	1.6	0	(0.65)	0.8	0	(1.55)	(0.5)
Plainville	Landfill gas	(0.90)	(1.02)	(0.7)	(4.50)	(5.09)	(10.0)	(10.8)	(12.2)	(26.1)
Nashua	Landfill gas	(0.90)	(1.03)	0	(4.50)	(5.14)	(5.0)	(10.8)	(12.3)	(13.7)
Randolph	Landfill gas	(0.90)	(1.02)	(0.3)	(4.50)	(5.12)	(11.1)	(10.8)	(12.3)	(30.0)
Barre	Landfill gas	(0.90)	(1.03)	0.2	(4.50)	(5.14)	(3.2)	(10.8)	(12.3)	(9.3)
Weighted Average[b]		(0.34)	(0.46)		(1.70)	(2.31)		(4.08)	(5.53)	
Total				17.4			(19.5)			(83.7)

[a]The name of the contractor was changed from U.S. Windpower to Kenetech Windpower in 1994.
[b]Average for projects weighted by their estimated annual generation.

A = Value of reduced greenhouse gas emissions due to reduction in emissions relative to existing emissions at the site. This value is the "credit" that the project receives because it reduces emissions of greenhouse gases at the current site. For example, a landfill has methane emissions. The landfill gas project would use the methane to generate electric power, effectively reducing the emissions of methane at the landfill site. The value of the "credit" is based on the \$/ton. CO_2 value stated at the top of the table.

B = Column "A" plus the value of avoided greenhouse gas emissions from existing and new generating sources. The value in Column B reflects an additional credit for the project, because the project would reduce the need to generate power from other units, thus reducing the greenhouse gas emissions from those units. The value in Column B is the *sum of Column A and this additional credit* from the project being a substitute for power from another unit.

C = Cumulative present worth of project costs above the utility's projected avoided costs (including a credit for avoided emissions). The value in this column is the *difference* between the total cost of power from the proposed project and the utility's projected avoided cost. The total cost of power from the project is its cumulative present value; future costs are discounted. The project gets a credit for the value of the avoided emissions compared to the plant used to calculate the projected avoided costs. The projected avoided cost is based on what the power would cost from a hypothetical natural gas plant.

RLP = Real levelized price.
CO_2 = Carbon dioxide.
MSW = Municipal solid waste.
Note: Numbers in parentheses represent negative values.
Source: New England Electric System, *Request for Approval of Contracts Executed as Part of the Companies' Renewable Resource Initiative, Vol. 2: Testimony and Exhibits*, August 1993, p. 44.

The values were used for informational purposes, but had no impact on future prices or emissions.

Recent Developments in Massachusetts

On December 22, 1994, the Massachusetts Supreme Judicial Court found the designation of monetary values by the MDPU to be beyond the range of its statutory authority. More specifically, the MDPU lacked the authority to regulate the impact of power generation on the environment by imposing a levy on power plant emissions. Protecting society from the environmental impacts of power plant emissions was deemed to be outside the scope of MDPU's responsibility.

This case was brought before the supreme court by Massachusetts Electric and the National Coal Association (NCA). The court did not agree with NCA's contention that the MDPU did not hold any authority to order the consideration of environmental impacts for planning purposes. However, the court agreed with Massachusetts Electric's contention that the MDPU's oversight should not result in extra costs to be borne by the ratepayers.

Table 8. New England Electric's Existing Resources
(Includes Committed Resources)

Description	MW
Demand-side Management (Supply-equivalent)	300
Coal-fired Baseload Generation	1,350
Oil- and Oil/Gas-fired Intermediate Capacity	850
Hydroelectric Plants	580
Nuclear Entitlements and Participation	580
Utility Purchases	1,000
Nonutility Purchases	400
Pumped Storage, Diesels, and Other Facilities	750
Unit Sales to Other Utilities	-200
Total	**5,610**

Source: New England Electric System, *Integrated Least Cost Resource Plan for the Fifteen Year Period 1994-2008,* submitted to the MDPU on June 1, 1994.

While the court remanded the matter for consideration by the MDPU, the operational impact of the court's decision will be to permit the utilities to exclude incorporating externality values from their resource planning submissions. In its June 1, 1995, order (D.P.U. 94-162), the MDPU supplanted the existing IRM procedures "by which resources are planned, solicited, and procured by certain investor-owned electric companies operating in the Commonwealth of Massachusetts" by establishing procedures for integrated resource planning. These orders do not embody the MDPU's externality policy.[148]

In view of what is stated above, it is possible to gain the impression that consideration of environmental externalities is no longer required. However, in a Boston Edison Company demand-side management preapproval case, the MDPU indicated that companies were still required to include "reasonably foreseeable environmental control requirements with cost implications for ratepayers," when weighing resource procurement alternatives (D.P.U. 95-1-CC at 12-14). The MDPU, however, did not specify which method or approach should be followed. Thus, each utility "must present evidence that it has taken these potential costs into account, and has included the avoidance of them in its calculations of the cost effectiveness of its demand-side management programs and its resource decision process."[149]

[148]D.P.U. 94-162.

[149]Theo MacGregor, Massachusetts Department of Public Utilities, "Environmental Externality Policy in Massachusetts," paper presented to the NARUC Energy Conservation Committee, Subcommittee on the Environment (Washington, DC, February 1995).

5. The State of Wisconsin Case Study

This chapter describes the decisions of the Wisconsin Public Service Commission (PSCW) on externalities and the manner in which the State's largest investor-owned electric utility, Wisconsin Electric Power Company (WEPCO), has considered externalities in its resource planning. The information presented in this chapter was gathered from an analysis of the relevant decisions and orders by the PSCW. Submissions made by WEPCO were also analyzed. An evaluation of impacts (of incorporating externalities) is based on discussions with State regulatory authorities and the WEPCO officials.

Treatment of Environmental Externality Issues at PSCW

The PSCW maintains that it had "an early start with, and has a proud tradition of, involvement with environmental concerns."[150] The starting point for the PSCW was the enactment of the Wisconsin Environmental Policy Act in 1971 requiring the PSCW to review the environmental effects of all its major actions. This was followed by the passage of the Power Plant Siting Law in 1975 requiring the PSCW to consider health, safety, and environmental issues before approving utility plans. The State laws also require that the advance plans for resources submitted by utilities take environmental issues, among others, into account.

The PSCW maintains that all Advance Plans (APs) since 1978 have taken environmental considerations of one kind or another into account.[151] Advance Plan 2 (1980), for example, recognized that the impacts of air pollutants (i.e., externalities) are costs that are not reflected in the standard cost/benefit analysis. A major study to examine the effects of acid deposition was accordingly ordered. Subsequently, Advanced Plans 3 and 4 took other externality aspects into account. Advance Plan 4 (1986) directed the utilities to submit future plans through "integrated resource planning." Within this framework, costs and benefits including those that are "Not Easily Expressed into Dollars (NEEDS)" were also to be considered.[152]

Advance Plan 5 (1989) directed the electric utilities to incorporate environmental costs in their evaluation of options. Specifically, utilities were required to apply a 15 percent "noncombustion" credit to ways of satisfying demands that do not involve the burning of fuels (in an attempt to promote demand-side management resources). Critics point out that this requirement had little impact on utility plans since the credit was not enough to overcome the private cost disadvantages of noncombustion options.[153]

The PSCW also recognized that there are externalities other than those caused by combustion. Utilities were directed to develop methods to permit inclusion of other externalities in Advance Plan 6. While various methods of incorporating externalities in the resource planning process were advanced and debated, the PSCW concluded that "monetization" represented the most straightforward method since it sets a value for a specific amount of externality.[154] The PSCW emphasized setting monetized values for greenhouse gas emissions, however, in the belief that emissions of carbon dioxide, methane, and nitrous oxide would be subject to national or international regulation.

[150]State of Wisconsin, Public Service Commission, *Advance Plan 6: Staff Issue Paper - Externalities* (Madison, WI, October 1991), p. 3.

[151]An "Advance Plan" is filed by Wisconsin's electric utilities every 2 years, pursuant to 196.491 Wisconsin Statutes and Wisconsin Administrative Code Chapter PSC 111. The purpose of the Advance Plan is to inform the PSCW and the general public of the utilities' plans for the future.

[152]NEEDS was the term used by the PSCW to describe externalities. See State of Wisconsin, Public Service Commission, *Advance Plan 6: Staff Issue Paper - Externalities* (Madison, WI, October 1991), p. 4.

[153]This requirement also worked against the use of renewable technologies (like biomass) that used combustion to produce power. See Research Triangle Institute, *Accounting for Externality Costs in Electric Utility Planning in Wisconsin (Final Report)* (Research Triangle Park, NC, 1991), pp. 2-1 through 2-27.

[154]PSCW recognized the implicit appeal of the "damage cost method" in estimating the public's willingness to pay to avoid externalities. However, consideration of that method was not taken up for want of sufficient information. Docket No. 05-EP-6, p. 49. For additional discussion of the methods considered by the PSCW, refer to State of Wisconsin, Public Service Commission, *Advance Plan 6: Staff Issue Paper -Externalities* (Madison, WI, October 1991).

The above conclusions are reflected in PSCW's order of September 15, 1992, mandating that utilities use certain monetized externality values when determining the economic cost of resource options in their planning process.[155] Utilities are to use these values when comparing demand-side management programs as well as generation capacity options. The values are to be applied plant by plant and are to be considered as energy-related cost options. As such, there will be no impact on demand- or capacity-related costs.

These externality values are also to be used in the design and implementation of demand-side management programs. Hour-by-hour marginal energy costs, including carbon dioxide costs, are to be projected and compared to the costs of reducing the demand. This procedure credits demand-side management programs for the production of greenhouse gases that these measures avoid.

The utilities are also to keep these values in mind when considering incentives for nonutility generators to use renewable energy resources in producing the electric power that they sell to utilities. In addition, the PSCW requires utilities to consider externalities other than the regulatory risks associated with greenhouse gases. PSCW recognizes that some externalities cannot be easily measured, but notes that damage-cost estimates are appealing.

The PSCW limited its order to the risk of future regulation because of significant controversy over its authority in the area of air pollution. Utilities claim that legislation states that the PSCW may not reject a certificate of public convenience and necessity because of air pollution impacts if the utility is in compliance with regulations. The PSCW's interpretation is that the Wisconsin legislature did not intend to preclude the PSCW from accounting for environmental externalities, only that it not issue clean air standards that are more stringent than State standards in effect. The PSCW makes the important distinction that externality values are not a way of imposing emission standards on utilities. Rather, they are a means of more accurately accounting for the total cost of a resource option, so that its costs and benefits can be compared to other options.

Two utilities are exempt from the application of the externality values because they operate in several States. Wisconsin considers it unreasonable to impose its specific order on these utilities because other States have other regulations. The utilities would be subject to conflicting requirements.

Externality Values Adopted by Wisconsin

The externality values (in 1992 dollars) stipulated by the PSCW for greenhouse gases are:[156]

- Carbon dioxide . . . $15 / ton ($ 0.0075 / lb)
- Methane . . . . $150 / ton ($ 0.075 / lb)
- Nitrous oxide . . . . $2,700 / ton ($ 1.35 / lb).

These values are used as a hedge against the risk of future greenhouse gas regulations. Utilities are to multiply the monetized values by the amount of greenhouse gases that the plant will emit, and apply the resulting costs to the energy-related costs of the plant for the period during which the energy is generated.

The externality values adopted by the PSCW are a compromise selected from a wide range of possible values. As an example, carbon dioxide reduction values presented to the PSCW (Table 9) ranged from a high of $50 / ton of carbon dioxide to almost nothing at all.

During the planning process, utilities in the State can offset greenhouse gas emissions. As an example, a utility could consider tree planting or forest protection, thereby offsetting carbon dioxide emissions associated with a resource plan.[157] In such a case, the monetized greenhouse externality values would then apply to the remaining balance. The PSCW stressed that the offset method should be reliable and persistent and should cost less than the monetized value of carbon dioxide.

The Integrated Resource Planning (IRP) Guidelines in Wisconsin

In February 1990 and July 1993, the PSCW revised and approved the *Integrated Resource Planning Guidelines for Wisconsin*. These guidelines were developed cooperatively with the electric utilities in the State and are

[155]*Findings of Fact, Conclusion of Law and Order,* with reference to the Wisconsin Public Service Commission's Docket No. 05-EP-6.

[156]Analysis made by the Tellus Institute of Boston and the Wisconsin Commission staff show clearly that the effect of the CO_2 value on the increased costs dominates the effect of the externalities values of the other gases. The CO_2 costs account for at least 97 percent of the total increase in cost in both coal and natural gas plants. See Stephen Bernow, et al., *Valuation of Environmental Externalities for Electric Utility Resource Planning in Wisconsin* (Tellus Institute, Boston, November 1991).

[157]Demand-side management programs were not considered as a feasible offset.

Table 9. Range of CO_2 Externality Values Compiled by the Wisconsin Public Service Commission

Source of Estimate	Value (dollars per ton CO_2)
Nordhaus (for a 50-percent Reduction)	50
Oregon PUC/U.S. Department of Energy 1991 Study (High End of Range)	40
Nordhaus (for a 30-percent Reduction)	25
Citizens for a Better Environment Recommendation in Advance Plan 6	23
Massachusetts PUC	23
Nevada PUC	23
Nordhaus (for a 25-percent Reduction)	15
Wisconsin Commission Decision	15
Oregon PUC/ U.S. Department of Energy (Low End of Range)	10
California Energy Commission and Public Utility Commission, 1991	7.50
New York Public Service Commission	1

CO_2 = Carbon dioxide.
PUC = Public Utility Commission.
Source: Reproduced from Wisconsin Public Service Commission, Docket No. 05-EP-6, Exhibit No. 363.

applicable to the planning process used by Wisconsin Electric.[158] Integrated plans evaluate and include demand-side and supply-side resources on a consistent basis to provide efficiency benefits to the ratepayers.

The PSCW requires that the integrated planning process be done jointly by the utilities. This joint plan contains projections of statewide demand for electricity over a 20-year planning horizon together with recommendations with respect to the acquisition of additions to capacity. The joint plan addresses major issues such as cost; reliability; efficiency; and the health, safety, and environmental effects of various plans for meeting the future electrical energy needs of the State. Resource options are compared using avoided cost—the cost a utility would not have to pay if it avoided supplying a customer with power from a conventional power plant.

In addition, each utility also submits its own integrated resource plan in the form of a report termed the Advance Plan. The purpose of the Advance Plan is to inform the PSCW and the general public of the utility's plans for the future.

In view of what is stated above, the integrated resource planning is a two-step process in Wisconsin. In the first step, a base forecast of need for electricity is developed jointly by the utilities in the State. The second step is to determine which resources individual utilities should acquire. The PSCW issues an order once every 2 to 3 years approving an electric plan that includes new power plants, energy conservation measures, and large electric power transmission lines. The PSCW, however, notes that the utilities' willingness to plan jointly in this type of process is changing due to an increase in competitive pressures.

Resource Planning by the Wisconsin Electric Power Company[159]

In January 1994, Wisconsin Electric submitted its Advance Plan 7, containing its forecast for the 1994-2013 period. This plan shares the common features of the joint plan submitted by the electric utilities in the State in terms of which all utilities are required to use the integrated resource planning guidelines in preparing the long-term plans. The process involves evaluation and selection of a bundle of supply- and demand-side options that provide energy requirements reliably and at the lowest cost. The Wisconsin Statewide Integrated Planning Committee (which is assisted by a number of task forces) is entrusted with the task of

[158]For additional information on this subject, see "Prepared Testimony of Timothy Kay - Docket No. 05-EP-7 during the week of Nov. 28, 1994" and "Revision of the Least Cost Planning Guidelines for Wisconsin" issued by the PSCW on August 26, 1993. For a chronological development of the integrated resource planning process in the State, see Edison Electric Institute, "*Integrated Resource Planning in the States - 1994 Source Book*" (Washington, DC, 1995), pp. 409-420.
[159]Wisconsin Electric Power Company is commonly referred to as WEPCO.

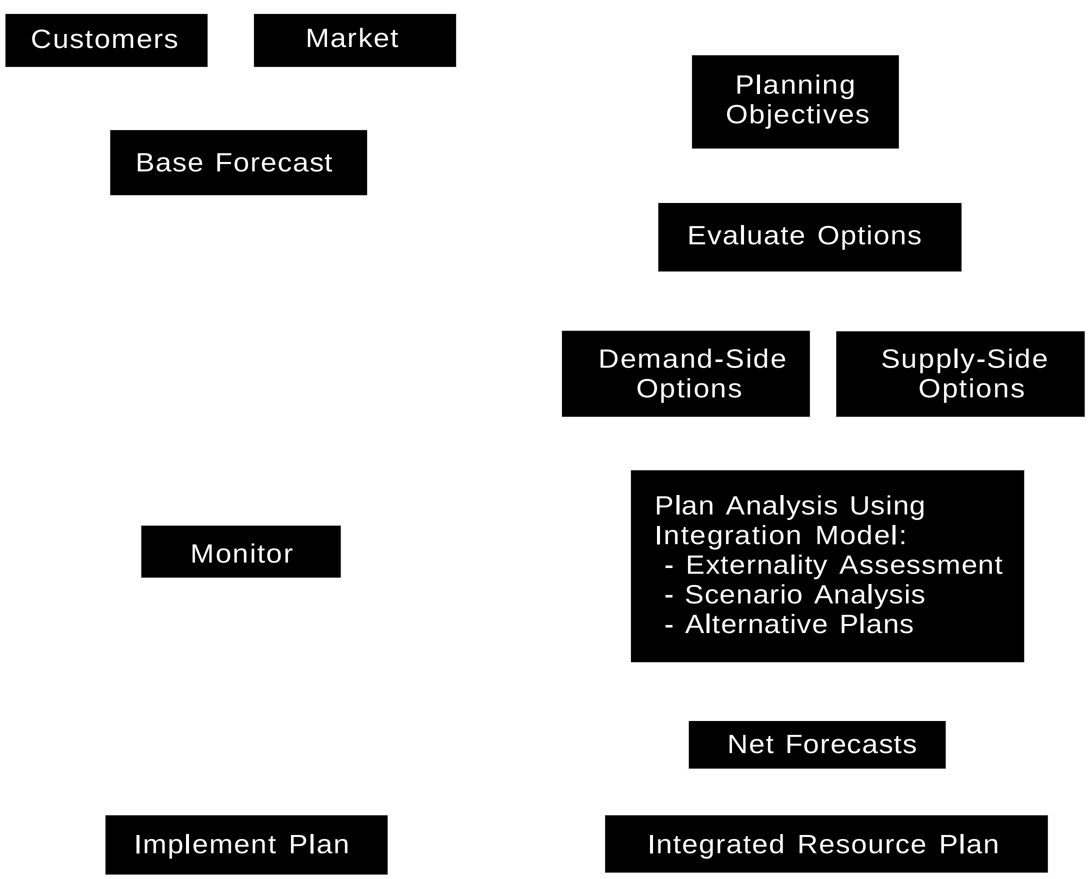
overseeing the formulation of utilities' plans.[160] Figure 2 depicts the flow diagram of the current integrated resource planning process used in the preparation of Advance Plan 7. The plan formulated by Wisconsin Electric follows the outline shown in Figure 2.

In developing the long-term forecast, a number of features are common to all utilities. These include:

- Development of an extensive information database on demand-side options (energy efficiency measures, load management, etc.) and supply-side options (conventional generation, new technologies, renewable resources, system efficiency improvements, nonconventional sources including purchases, etc.)

- Determination of objectives for demand-side options' evaluation. Different perspectives on the subject include costs for participating and nonparticipating customers, total and societal costs, utility's revenue requirements, etc. An appropriate discount rate, environmental externalities, and other socio-economic factors are also taken into account. These considerations are intended to enhance quality, marketability, and reliability from various perspectives.

Figure 2. Integrated Resource Planning Process in Wisconsin



Source: *Advance Plan 7: Planning Wisconsin's Electrical Future*, submitted by electric utilities to the Wisconsin Public Service Commission on January 17, 1994, pp. C1-2.

[160]The task forces include Demand-Side Management, Power Supply Planning, Renewable Energy, Externalities, Load Forecasting, and Environmental and Financial Analysis. Some of these functional task forces are further combined into a Joint Planning Task Force to implement joint utilities' planning.

- Consideration regarding interfuel substitution options

- Assessment of the effect of externalities involved using the monetized values as indicated earlier. These values are: carbon dioxide – $15/ton, methane – $150/ton, and nitrous oxide – $2,700/ton. The cost of compliance with the Clean Air Act Amendments is presumed to be internalized.[161]

- Coordination of plans with other utilities to determine if there exist any cost-effective options to coordinate activities among utilities in the State

- Development of "contingency plans" to evaluate various scenarios with demand rising higher or lower than projected. Other perspectives may also be included. Sensitivity analysis performed under differing assumptions is also undertaken.

After taking the common elements of the planning/forecasting process into account, Wisconsin Electric's base forecast was developed using a series of models which incorporate historical data of its service territory, sectoral energy sales forecast, and economic and energy use assumptions.[162]

Supply-side options to meet the projected system load include conventional and advanced technologies, non-utility power, and purchase options.[163] Renewable technologies including wind, wood and biomass, waste-to-energy, hydro, and solar were also considered. All supply-side options were screened on the basis of energy and capacity costs.[164] Wisconsin Electric also supports the Advanced Light Water Reactor program but notes that its design availability is still 5 to 6 years away.

Energy efficiency, conservation, and load management constitute the core of Wisconsin Electric's bundle of demand-side options. All demand-side management options are screened using a cost-benefit model.[165] Wisconsin Electric maintains that the cumulative impact of these programs in the aggregate is to significantly dampen the growth in summer peak demand.[166]

In the final step, the supply-side options were evaluated simultaneously with demand-side options to determine their inclusion in the resource plan.[167] In the first case, the process was conducted in which only internalized costs were considered followed by another case in which greenhouse gases were monetized using values specified by the PSCW. In neither of these iterations were renewables options selected. Wisconsin Electric then ran two more iterations with a "fixed" set of renewable options assumed in the plan. The results did not materially change.

Wisconsin Electric is required to include specific monetized values to cover the risk of future greenhouse gas regulations in determining the economic cost of new

[161]Fossil fuel options are evaluated using the monetized costs in both dispatch decisions and as part of the annual cost of operation. The PSCW further requires that the utilities expand their analysis by developing methods to consider "a broader array of all non-monetized externalities attributable to demand-side and supply-side options as part of their evaluation process." See *Advance Plan 7 - Planning Wisconsin's Electrical Future*, Appendix C1, (filed by the Wisconsin utilities in January 1994), pp. C1-4.

[162]The derivation of the base forecast uses two separate but related approaches. The econometric approach uses forecasts of underlying economic variables and projected growth in population and other appropriate variables. The end-use or the engineering approach evaluates sectoral demand growth as a function of factors specific to each sector. The end-use forecast then adds up all the end uses to arrive at the total base forecast.

[163]Wisconsin Electric also took into account plants that may have to be retired during the planning period. As an example, the two Point Beach nuclear units (a total of 984 MW) are expected to be retired around 2010 and 2012, though any decision will be based on future relicensing studies. Two 500-MW coal units are used as place holders in Wisconsin Electric's plans, in case the two nuclear units are retired.

[164]Wisconsin Electric uses a large number of models to arrive at its forecast in addition to those prescribed for use by the PSCW. The company also evaluated over 200 technologies (with respect to the conservation and load management) and included more than 130 in its resource plan. These programs reduced its peak demand growth from 2.1 percent to 1.5 per cent per year during the 1994-2013 period.

[165]Demand-side options that were selected by the Wisconsin Electric (in the screening process) were those with a benefit/cost ratio of 1.0 or more.

[166]Wisconsin Electric's plan also has more load management than in the least-cost plan. The plan is to have 592 MW of additional demand reduction by 2003. The utility plans on increased demand-side management to reduce its system peak demand by about 540 MW by the summer of 1994 or 11.7 percent of its base peak demand to 955 MW in the year 2003, or 16.8 percent of base peak demand. The "Smart Money" program offers financial rebates and low- or no-interest loans for installing energy-efficient appliances and equipment. The company also offers fee incentives to pay for fees to evaluate or implement building efficiency improvements.

[167]Simultaneous evaluation of the demand- and supply-side options involves the use of IRP-Workstation - the software that the PSCW requires utilities to use. Monetized values for the emissions are included in both supply- and demand-side costs. This cost also includes a projected cost of SO_2 emission allowances.

generating plants. Thus, the externality values specified by the PSCW were included in evaluating available options. According to the documents submitted by the utility, the development of demandside management programs and the evaluation of fossil supply options included monetized externality values.[168]

Uncertainty Analysis

Wisconsin Electric recognizes that there may be many uncertainties in the future. Planning in an environment of uncertainty "requires resource plans which embody tradeoffs between cost minimization under current conditions and risk minimization with respect to future uncertainties." [169]

Wisconsin Electric identifies critical areas that lead to uncertainty. These include load forecast, fuel price forecast, and monetized externality values. Different combinations of these projections define different scenarios. A decision-analysis methodology (which allocates probability values to critical assumptions) was used to evaluate plan performance under varying conditions.[170]

Wisconsin Electric's plan resulting from the uncertainty analysis did not suggest any significant changes. The new construction mix turned out to be primarily gas-fired with no new renewables in the plan. Yet, Wisconsin Electric decided to incorporate renewable energy resources in its plan in the belief that improvements in technology and cost may render renewables more attractive in the future.

Significant conclusions of Wisconsin Electric's findings include:[171]

- Natural gas will be the fuel of choice for most of the new capacity in the future.
- There will be no new renewable energy capacity.
- Both dispatchable and non-dispatchable load management are included.

Wisconsin Electric's Resource Current Inventory and Future Requirements

Wisconsin Electric owns and produces most of the electricity necessary to meet customer loads. Its 1993 total generating system consisted of 981 MW (19.5 percent) of nuclear generation, 3,531 MW (70.3 percent) of coal-fired steam generation, 439 MW (8.7 percent) of combustion turbine and diesel generation, and 75 MW (1.5 percent) of hydro generation for a total of 5,026 MW. Based on this generating mix, the relative contribution of each energy source is currently as follows: coal, 60 percent; nuclear, 30 percent; purchases, 8 percent; hydro and other renewable energy, 1.5 percent; and gas and oil, 0.5 percent.[172]

Supply-side additions total 2,367 MW for the 1994-2013 period (Table 10). These include:

- 187 MW of renewable resources (102 MW wind, 60 MW wood/biomass, 9 MW hydro, 11 MW waste-to-energy, and 5 MW solar)[173]
- 14 peaking units totaling 1,162 MW
- 4 intermediate load units totaling 800 MW
- One cogeneration plant of 218 MW.

Note that the inclusion of renewables is governed by considerations other than externalities.

Wisconsin Electric's Assessment of Externality Considerations

Wisconsin Electric contends that the inclusion of externality values (in plan formulation and optimization)

[168]In evaluating supply-side options, monetized emissions were used both as a cost for dispatch decisions and as a part of the total cost of operation. See *Advance Plan 7: Technical Support Document D1* submitted by the Wisconsin Electric in January 1994 to the Wisconsin Public Service Commission, p. D1.6-6.

[169]*Advance Plan 7: Technical Support Document D1,* submitted by the Wisconsin Electric in January 1994 to the Wisconsin Public Service Commission, p. D1.6-7.

[170]The decision analysis model used by Wisconsin Electric is called "Multi-Objective Integrated Decision Analysis System (MIDAS)." The model is used to compute the present value of revenue requirements for each scenario. The model compares planning and dispatch combinations with and without monetization with respect to the greenhouse gas emissions. The MIDAS capacity plan is used with another model to develop data for the IRP filing.

[171]However, in the near term, demand is met by purchases, gas-fired combustion turbines, and cogeneration projects. In this time period, there are plans for a 4-MW waste-to-energy facility and a 2-MW wind demonstration project.

[172]*Advance Plan 7: Planning Wisconsin's Electrical Future* filed by the Wisconsin Utilities with the Wisconsin Public Service Commission in 1994, p. D1.1-2.

[173]Currently, Wisconsin Electric has 88.4 MW of renewable capacity (all hydroelectric).

Table 10. Wisconsin Electric Power Company Advance Plan 7, 1994-2013
(Number of Capacity Additions by Type and Size of Unit)

Year	Combustion Turbine	Intermediate Load Unit	Base Load Unit	Capacity Purchase: 1 Year Firm	Capacity Purchase: Multi-year	Renewable
1994	2 (83 MW)			1 (280 MW)		
1995	4 (83 MW)					1-WE (4 MW)
1996	[a]1 (71 MW)	[a]1 (147 MW)				
1997					[b]1 (100 MW)	[c]1-W (2 MW)
1998						
1999						1-WE (7 MW)
2000						1-W (50 MW) 1-W/B (30 MW)
2001	1 (83 MW)					
2002	1 (83 MW)					
2003	2 (83 MW)					
2004	1 (83 MW)					
2005	1 (83 MW)					1-W (50 MW) 1-W/B (30 MW)
2006						1-H (9 MW)
2007		1 (200 MW)				
2008						
2009		1 (200 MW)				
2010		1 (200 MW)				1-S (5 MW)
2011	1 (83 MW)		1 (500 MW)			
2012		1 (200 MW)				
2013	1 (83 MW)		1 (500 MW)			

[a]Cogeneration unit.
[b]13-year purchase.
[c]Demonstration unit.
H = Hydro. MW = Megawatt.
S = Solar. W = Wind.
WB = Wood/biomass. WE = Waste to energy.
Source: Wisconsin Electric Power Co., *Advance Plan 7: Technical Support Document D1* (Madison, WI, January 1994), p. D1.C-13.

has only a small impact on the total internal costs and thus on the selection of resources. In defending this contention, the company states that it "is because the least-cost plan optimized without externality values is already primarily composed of demand-side management and new gas-fired generating facilities. Including the value of externalities does not change the plan."[174]

Wisconsin Electric evaluated the effects of including or not including externalities in two interrelated decisions (Table 11). The first decision concerns planning the resource mix, for example, the decision on what type of power plant capacity to add to the existing system. The second decision concerns how to dispatch existing capacity to meet demand. The internal costs for the utility will be the lowest if externalities are not considered for either decision. Therefore, the internal cost in the second column is indexed at 100. The other columns show all combinations for the two decisions. The conclusion shown is that the difference in the total costs is not large and the difference in Wisconsin Electric's internal costs increases at most by 1.3 percent.

A recently completed study indicates that externality considerations by Wisconsin Electric only changed the order of deployment of units; a 200 MW baseload unit

[174]*Advance Plan 7: Planning Wisconsin's Electrical Future* filed by the Wisconsin Utilities with the Wisconsin Public Service Commission in 1994, p. D1-16.

Table 11. Effect of Monetized GHG Externality Values on Wisconsin Electric's Resource Mix and Costs
(As a Percentage Relative to Actual Costs)

Cost Component	Optimal Resource Mix, *Without* Considering Externalities		Optimal Resource Mix, *With* a Consideration of Externalities	
	Operate **With** Externalities	Operate **Without** Externalities	Operate **With** Externalities	Operate **Without** Externalities
Internal	101.1	100.0	101.3	100.2
External	55.5	56.9	55.3	56.7
Total	156.6	156.9	156.6	156.9

Note: GHG = Greenhouse gases.
Source: Wisconsin Electric Power Co., *Advance Plan 7: Planning Wisconsin's Electrical Future*, "Technical Support Document D1," Submitted to the Wisconsin Public Service Commission in January 1994, pp. D1.C-9 through D1.C-18.

was substituted by a 200 MW intermediate-load range. Further, the company points out that two changes were made, in part, on *qualitative* consideration of externalities.[175] Apart from this change, there were no other effects on the supply side. Note, however, that:

- Atmospheric fluidized bed combustion coal plants were considered for baseload only through 2004 when integrated gasification combined-cycle coal units were assumed to offer greater efficiency and emissions improvement.[176]

- Despite the fact that renewables were not cost-effective, the utility incorporates some renewables with the expectation that future cost reductions will make them more attractive. The PSCW notes that this explanation makes it unclear whether the inclusion of renewables was based on cost advantages (i.e., economics) or externality considerations.[177]

Wisconsin Electric's analysis shows that the overall impact of including monetized externality values on demand-side management programs is not significant.[178] No other programs are affected by qualitative externalities (other than implicitly) and no technologies are excluded due to externalities. In addition, renewable energy resources fail to be selected in Wisconsin Electric's least-cost plan in both cases that include or exclude monetized externalities for greenhouse gas emissions (Table 11).

The use of the greenhouse gas externality values in the analysis has only a very small impact on the total (internal) costs of the system. According to Wisconsin Electric, the reason is that the resource mix, without consideration of externality values, already has a considerable amount of demand-side management programs and new gas-fired generating facilities.

The conclusion, then, is that the greenhouse gas externality values have little impact on the cost-effectiveness of the renewables and a very small impact on demand-side management programs.

Another point of interest is to note that the impact of externality considerations on costs is rather small—about 1 percent—as long as monetary values are used only for planning purposes. If regulations for a carbon dioxide tax are introduced, the cost impact will be significantly higher.

[175]Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utility's Mix of Resources: Case Studies of Massachusetts, Wisconsin and California* (Oak Ridge, TN, July 1995). Also, see prepared testimony of David B. Iliff of the Wisconsin Public Service Commission, Docket No. 05-EP-7, during the week of November 28, 1994.

[176]The utility's analysis suggests that integrated gasification combined cycle (IGCC) plants would be cost-effective, with or without consideration of the GHG monetary externality values. Discussions with the utility officials indicated that these IGCC coal-fired plants were placeholders for the two nuclear plants in the event they were retired.

[177]Testimony of David B. Iliff of the Wisconsin Public Service Commission, Docket No. 05-EP-7, during the week of November 28, 1994.

[178]The overall impact of using GHG externality values on DSM is that they increased the projected level of DSM by as little as 10 MW per year through the year 2013. As an example, in 2003, about 5 percent of the demand impacts (MW) and 8 percent of the MWh impacts are due to using monetized externalities in the plan.

PSCW's Assessment of the Impact of Considering Externalities on Wisconsin Electric's Resource Mix

The PSCW staff released in July 1994 their assessment of the electric utility plans with specific reference to Advance Plan 7.2.[179] Among other items, this assessment report details the directives issued to the utilities for improving their plans.

The PSCW's directives to the utilities were to use externalities in two ways. First, they were to add monetized emission values to all power plants that produce greenhouse gases to reflect the expected costs of future controls or taxes on greenhouse gases. This action was expected to provide insurance against making wrong decisions. Next, the PSCW directed the utilities to develop their own method for considering environmental impacts that were not covered by the greenhouse adder. To perform this task, the utilities were to rely on such current information that was transparent and flexible.

The PSCW took notice of the fact that the power plants proposed for new capacity additions do indicate a shift generally from coal to natural gas. This impact would be reasonable to anticipate if the externality values for greenhouse gases were used in the evaluation process.

However, the utilities, including Wisconsin Electric, maintain that the shift is due to economic reasons and does not result from the incorporation of monetized externality values. The utilities present a somewhat similar argument to explain the increasing penetration of demand-side management programs.[180]

The PSCW maintains that utilities' consideration of externalities other than the greenhouse gases is not as clear.[181] Only some utilities took externalities other than greenhouse gases into account. The Commission intends to collect additional information in this area.[182]

The PSCW also attempted to visualize the future of externalities within a competitive environment that the utilities are likely to confront in the future. Including externality costs will raise production costs which will be reflected in retail rates. The utilities' interest is to keep costs down so that they can compete for (and retain) large industrial customers. Accordingly, the utilities may want to recover only the production costs. The PSCW, however, maintains that increased costs (resulting from inclusion of externalities) would be offset by a reduction in environmental costs. There was apparent disagreement between the PSCW and Wisconsin Electric over the costs of wind power and the effectiveness (e.g., participation rate) of DSM programs. This disagreement led to differences in their assessments of the least-cost plan. The utility had fewer demand-side management programs and less renewable energy in their plan than the PSCW staff thought there should be.[183]

Concluding Observations

Incorporation of externality considerations has not resulted in any perceptible shift in the resource selection process at Wisconsin Electric. The switch to natural gas is attributed to cost effectiveness rather than to externality considerations. The decision to use renewables is more in the nature of an insurance against the uncertainty of regulatory changes. In addition, the utility stands to gain experience as renewable technologies mature with the added expectation that costs may go down. With competition making inroads in electric generation, Wisconsin Electric's priority will be to retain its market share and the value of its equity. These objectives may be at odds with efforts to equate societal costs with private costs.

[179]State of Wisconsin, Public Service Commission, *Staff Assessment of Electric Utility Plans: Advance Plan 7* (Madison, WI, July 1994).

[180]State of Wisconsin, Public Service Commission, *Staff Assessment of Electric Utility Plans: Advance Plan 7* (Madison, WI, July 1994), pp. 56-60.

[181]Some of the utilities in the State had (prior to the issuance of the AP-6 order) entrusted the Research Triangle Institute to prepare a report dealing with the subject of environmental accounting. Its report, released in November 1991, deals with various methodological issues and approaches to externalities. The extent to which any of the approaches discussed in the report were adopted for implementation is not known. See Research Triangle Institute, *Accounting for Externality Costs in Electric Utility Planning in Wisconsin (Final Report)* (Research Triangle Park, NC, November 1991).

[182]For example, for Wisconsin Electric, PSCW staff said that there was no description of any consideration. In data request responses, the utility indicated that although there was "no explicit characterization" of qualitative externalities, they were still considered. See Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utility's Mix of Resources: Case Studies of Massachusetts, Wisconsin and California* (Oak Ridge, TN, July 1995).

[183]Discussions with the officials of the Wisconsin Public Service Commission and Wisconsin Electric in November 1994. See Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utility's Mix of Resources: Case Studies of Massachusetts, Wisconsin and California* (Oak Ridge, TN, July 1995).

6. The State of California Case Study

This chapter describes the decisions of the California Public Utility Commission (CPUC) on externalities and the manner in which the State's largest electric utility, Pacific Gas and Electric, has considered externalities in its resource planning. An evaluation of impacts of incorporating externalities is based on discussions with State regulatory authorities and officials of Pacific Gas and Electric.[184]

Treatment of Environmental Externalities in California

The State of California experiences some of the highest levels of air pollution in the country.[185] To alleviate this problem, the State air quality standards (in conjunction with Federal standards) specify allowable ambient concentrations for pollutants.[186] Controlling power plant emissions is, therefore, a vital part of the State's strategy in meeting required air quality standards.[187] A summary of environmental regulations affecting electricity generation in California is shown in Table 12.[188]

The California Energy Commission (CEC) identifies options (for implementation) in an attempt to meet the State's need for improvements in air quality. In its *1990 Electricity Report*, the CEC listed the following approaches to reduce emissions from power plants:

- Retrofitting existing facilities, replacing them with cleaner and more efficient gas-fired units, or substituting for them either nonpolluting or less polluting sources like demand-side management programs or renewables[189]

- Placing a monetary value on in-State and out-of-State residual emissions with respect to each major pollutant associated with electricity generation

- Stipulating offset availability within a market-based approach.

The CEC also directed that all costs and emissions impacts of compliance with air quality regulations be accounted for in performing the analysis of the cost effectiveness of power generation alternatives so that the cost of electricity to society could be minimized.[190]

The mandate to initiate the above actions stems from Assembly Bill 3995 passed by the California legislature

[184]Dr. Suraj P. Kanhouwa of the Energy Information Administration and Dr. Russell Lee of the Oak Ridge National Laboratory met with the State regulatory authorities in California as well as with the officials of Pacific Gas and Electric Co.

[185]California Energy Commission, *1990 Electricity Report* (Sacramento, CA, October 1990), pp. 5-1 through 5-18.

[186]Regulations to improve air quality standards have been in force in California since the 1960s, starting with the establishment of the automobile exhaust emission standards and the introduction of catalytic converters in the 1970s. At the same time, smoke stack pollution control devices were introduced to reduce emissions from power generation. The State's Clean Air Act of 1988 was designed to address California's unique air quality problems. See California Energy Commission, *1990 Electricity Report* (Sacramento, CA, October 1990), pp. 5-1 through 5-18.

[187]Environmental regulations cover emissions from power plants as well as emissions from other sources, such as automobiles and industrial facilities. However, not all sources of emissions are covered by regulations and the regulatory authorities recognize that even with current regulations in place, negative impacts remain with the result that their associated costs go unaccounted for in the price for energy. The discussion in this report deals only with externality considerations as applicable to power generation in California. See California Energy Commission, *Staff Testimony on Internalizing Externalities,* Docket No. 93-ER-94 (Sacramento, CA, September 15, 1994), p. 1.

[188]According to the California Energy Commission, the environmental regulations listed in Table 12 are those that may require review to ensure that environmental objectives are met or that may influence the development of the competitive electricity industry. See California Energy Commission, *Draft Final 1994 Electricity Report* (Sacramento, CA, June 1995), p. 3-25.

[189]Capital and operating costs of these options vary.

[190]Note that minimizing the environmental costs of providing power is one of the several objectives of regulatory authorities. Other traditional objectives are: ensuring the availability of reasonably priced power, its reliability, and the industry's good financial health. See California Energy Commission, *1992 Electricity Report* (Sacramento, CA, January 1993), pp. 47-65.

Table 12. Summary of Environmental Regulations Affecting Electricity Generation in California

Environmental Regulation	Applicability	Implications for Electricity Generation and Competitive Futures
Best Available Retrofit Control Technology (BARCT) Rules	Existing combustion power plants located in extreme, severe, and serious nonattainment areas	Air district where major utility boilers are located have all adopted Nitrogen Oxides (NO_x) BARCT rules. Most districts have plans for BARCT rules to control NO_x emissions from nonutility boilers and gas turbines. Districts have, or will soon adopt BARCT rules for nonutility boilers and gas turbines. This should levelize the playing field among existing power plants. Some existing BARCT regulations may have been drafted specifically for electric utilities, and therefore, may require modification to ensure that intent of regulations are met in a restructured industry. New power plants are generally cleaner than existing power plants using BARCT. Although now not enforced, regulations adopted in the early 1980s allow new cogeneration power plants to obtain emission reduction credits from displacing utility system emissions. It may be appropriate to reevaluate these regulations for a restructured electricity industry.
Electric Transmission Line Safety and Nuisance Regulations	In- and out-of-State transmission lines	A number of regulations govern the construction and operation of electric transmission lines in- and out-of-State. These regulations are intended to mitigate aviation hazards, fire hazards, communication interference, and shock hazards from electric transmission lines. Some existing regulations may place requirements on electric utilities to mitigate hazards, and therefore, may require modification to ensure that intent of regulations are met in a restructured industry.
Endangered Species Act	In- and out-of-State power plants	The Endangered Species Act of 1973 (PL 93-205 as amended) established a process for designating plants, insects, fish, and wildlife species in order to slow or cease their decline, and developing recovery plans for such species. Recently, in accordance with this legislation, several actions to protect endangered and threatened species have occurred in the west. Both the Northwest Power Planning Council and the NMFS have been developing revitalization plans for the listed endangered salmon of the Columbia River Basin over the last few years. These plans are likely to alter the current operations of the Northwest hydroelectric system in this region and affect electricity supply options.
Hazardous Materials Handling and Storage	In- and out-of-State power plants and transmission line substations	Generally, gas-fired power plants do not use or produce significant amounts of hazardous materials. The exceptions are chemicals for air and water pollution control, solvents used to clean equipment, and some chemicals that were used in transformers. Liability for hazardous waste cleanup of existing power plant or transmission line substations sites may complicate divestiture of electric utilities under restructuring.
New Source Review (NSR) Rules	New combustion power plants located in nonattainment areas in- and out-of-State	NSR rules require the use of Best Available Control Technology (BACT) and require that the emission reductions be obtained from other existing sources to offset any emission increases for the new source. Availability and costs of offsets may affect the viability of merchant projects. Merchant projects may increase volatility of offset or RECLAIM markets. Although BACT requirements will likely become more restrictive, over time, no significant implications for electricity generation are expected.
Prevention of Significant Deterioration (PSD)	New combustion power plants located in attainment areas in- and out-of-State	PSD require use of BACT (Federal definition),[a] limit the degree projects can degrade air quality, and protect visibility in national parks and wilderness areas. PSD may affect viability of new in- and out-of-State electricity resource options that might degrade visibility in national parks.
Reasonably Available Control Technology (RACT) Rules	Existing combustion power plants located in moderate nonattainment areas	RACT that apply to existing power plants in moderate nonattainment areas consist of low NO_x burners and combustion modifications. Protection of visibility in national parks may lead to emission retrofit requirements for existing sources, including electric generating facilities, both in- and out-of-State. RACT controls may be required for some power plants to limit visibility impacts, and may apply to NO_x, Sulphur Oxides (SO_x), and PM10 emissions, which may affect competitiveness of some sources.

Table 12. Summary of Environmental Regulations Affecting Electricity Generation in California (Continued)

RECLAIM	All large NO_x and SO_x sources in South Coast AQMD	...Rule 2001 (i) (2) excludes electric utility sources from SO_x trading program. Restructuring could void this excerpt...
SO_2 Acid Deposition Trading	Existing combustion power plants in- and out-of-State	Current regulations require SO_2 reductions from utilities. EPA is currently evaluating possibility of expanding regulations to non-utility sources.
Toxic Air Contaminants, Title VIII	In- and out-of-State power plants	Generally, in-State requirements are more significant than out-of-State requirements. Natural gas-fired power plants will not generally have significant emissions, although ammonia for SCR NO_x controls may be of concern. Coal-fired, municipal solid waste or geothermal power plants may have toxic and carcinogenic pollutants which may require regulation in the future.
Water Quality Act	In- and out-of-State hydropower plants	The Clean Water Act, originally enacted in 1972 (PL 92-500), controls pollutants released in the nation's lakes, rivers, and coastal waters. Among other things, the Act provides funding to local and State agencies for water treatment programs, requires discharge limits on pollutants, and establishes permit requirements. In *Jefferson County PUD No 1 and the City of Tacoma v. Washington (1994)*, the Supreme Court ruled that States may establish minimum stream flows for hydroelectric project under the Clean Water Act. Prior to this decision, the Federal Energy Regulatory Commission had relatively exclusive authority over hydropower projects under the Federal Power Act of 1920. This decision is expected to have a significant effect on hydroelectric projects that are facing licensing renewal.

[a]In many air districts in California, BACT means LAER (i.e., the most stringent emission limitation achieved in practice for a class or category of source). The primary difference between LAER and BACT (Federal definition) is that LAER does not require the consideration of environmental, energy, or economic impacts, whereas BACT does. BACT and LAER determinations do not require use of a specific technology.

AQMD = Air Quality Management District.
BARCT = Best available retrofit control technology.
NMFS = National Marine Fisheries Service.
NSR = New source review.
RECLAIM = Regional clean air incentives market.
SO_x = Sulfur oxides.
BACT = Best available control technology.
LAER = Least achievable emissions rate.
NO_x = Nitrogen oxides.
RACT = Reasonably available control technology.
SCR = Selective catalytic reduction.
SO_2 = Sulfur dioxide.

Source: Reproduced from California Energy Commission, *Draft Final 1994 Energy Report* (Sacramento, CA, July 1995), pp. 3-26 and 3-27.

in 1990. This legislation imposes—both on the CEC (California Public Resource Code section 25000.1) and the CPUC (Public Utilities Code section 701.1)—the requirement to calculate the cost-effectiveness of energy resources, including conservation and load management options, by attaching a value for any costs and benefits to the environment including air quality.[191]

In its next submission, the *1992 Electricity Report*, the CEC grappled further with the question of emissions valuation estimates. The CEC directed the utilities to use estimates derived from the revealed preference (or control costs) and the damage function approach (Table 13).[192] According to the CEC, both these methods internalize environmental externalities in evaluating electricity resources. The values for control costs are invariably higher than those for the damage function approach (except PM10). However, the CEC states that differences between the values are not large enough to affect longrun planning decisions; their only effect is in the timing of a new resource addition. In addition, the intent to encourage low-emission emitting or renewable

[191]In its Decision 91-06-022, the CPUC determined that since emissions from power plants lead to environmental impacts that impose measurable costs on society, utilities should account for these emissions when they evaluate long-term purchases of power. For *short-term* purchases (5 years or less), however, externality values do not need to be considered. The reason given by the CPUC is that it would ease the transition to using externality values and help cushion any rate impacts that might result from incorporating externalities in evaluating long-term purchases.

[192]These approaches have been discussed in Chapter 3. For additional CEC comments, see California Energy Commission, *1992 Electricity Report* (Sacramento, CA, January 1993), pp. 47-65.

Table 13. Comparison of Residual Emission Reduction Values for 1992
(1989 Real Dollars per Ton per Year)

Air Basin or District	Valuing Method[a b]	NO_x	SO_x	ROG	PM10	CO[c]
South Coast	Damage Functions	14,483	7,425	6,911	47,620	3
	Control Costs	26,400	19,800	18,900	5,700	9,300
Ventura County	Damage Functions	1,647	1,500	286	4,108	0
	Control Costs	16,500	6,200	21,100	1,800	Attainment
Bay Area	Damage Functions	7,345	3,482	90	24,398	1
	Control Costs	10,400	8,900	10,200	2,600	2,200
San Diego	Damage Functions	5,559	2,676	98	14,228	1
	Control Costs	18,300	3,600	17,500	1,000	1,100
San Joaquin Valley	Damage Functions	6,473	1,500	3,711	3,762	0
	Control Costs	9,100	17,800	9,100	5,200	3,200
Sacramento Valley	Damage Functions	6,089	1,500	4,129	2,178	0
	Control Costs	9,100	9,600	9,100	2,800	5,000
North Coast	Damage Functions	791	1,500	467	551	0
	Control Costs	6,000	3,000	3,500	900	Attainment
North Central Coast	Damage Functions	1,959	1,500	803	2,867	0
	Control Costs	9,100	3,000	9,100	900	Attainment
South Central Coast	Damage Functions	1,647	1,500	286	4,108	0
	Control Costs	9,100	3,000	9,100	900	Attainment
Southeast Desert	Damage Functions	439	1,500	157	680	0
	Control Costs	6,000	19,700	3,500	5,700	2,900
Districts which are attainment for O_3 but not for PM10	Control Costs	6,000	3,000	3,500	900	Attainment

[a]The damage function values shown above are estimates of the external or social costs of residual air emissions. In *ER 92*, such costs are based on an evaluation of the damages resulting from the residual emissions remaining *after* rules and control strategies are implemented to attain ambient air quality standards. Thus, the values assume successful implementation of a local air district's air quality management plan over time, with attainment of ambient air quality standards occurring by the year required.

The Energy Commission's analysis of future electricity generation options in *ER 92* includes both the internal private costs and benefits of power plant generation and, responding to Section 25000.1(c), the external social costs and benefits of power plant generation. The Energy Commission's purpose in adopting damage-function air emissions values is to estimate the external costs of air emissions based on the marginal social benefit of reducing residual power plant emissions remaining after rules and regulations are implemented along the path to attainment of ambient air quality standards. Therefore, for the South Coast AQMD, for example, the Energy Commission examined the social benefit of reductions in power plant air pollutants, assuming full implementation of all control strategies and control costs on power plants in accordance with the South Coast AQMD's rules, regulations, and the 1991 Air Quality Management Plan (AQMP), which sets forth the emission reductions required for attainment of air quality standards.

While the Energy Commission recognizes that the South Coast AQMD does not agree with the use of damage-function methodology to evaluate a single emissions source or the resulting values from the methodology, the Commission nevertheless adopts these values to allow finalization of *ER 92* resource decisions and recognizes that these values need to be refined for future decisions.

[b]Damage function values and control cost values were escalated at different rates.

[c]CO damage function values were rounded to the nearest dollar.

AQMD = Air Quality Management District. CEC = California Energy Commission.
CO = Carbon monoxide. NO_x = Nitrogen oxides.
O_3 = Ozone. PM_{10} = Particulate matter less than 10 microns in diameter.
ROG = Reactive organic gases. SO_x = Sulfur oxides.

Note: *ER 92* stands for *1992 Electricity Report.*

Source: Reproduced from California Energy Commission, *1992 Electricity Report* (Sacramento, CA, January 1993), p. 55.

technologies is not enhanced by using either set of values.

According to the CEC, the ineffectiveness of using externality values could be handled better if there existed a market mechanism to price residual emissions. Legislative enactments (California Assembly Bills 2198 and 1090) required that resource acquisition explicitly recognize the environmental and fuel-diversity values of renewable energy resources. Based on that legislation and the fact that no such market currently exists for residual emissions, the CEC's recommendations, as reported in the *1992 Electricity Report*, include:

- Low-emitting technologies and renewables have a role to play in reducing emission levels.
- A set-aside for renewables is warranted for a portion of any new capacity.
- Development of an emissions trading program was considered to be the most effective way to include the value of pollution costs in society's decisions.
- Pending the development of a market for emissions trading, residual emission values would continue to be estimated, applied, and included in resource planning decisions.
- The CEC should investigate scientific problems associated with the valuation of externalities.
- An analysis of the socially least-cost options should include all other segments of the economy besides power generation.
- Other environmental externalities (pertaining to land and water, for example) should also be considered in due course.

The cost effectiveness of energy resources is determined by including a value for any costs and benefits to the environment including air quality. The State environmental laws have also started the application of market principles in regulations that affect power plants as well other large sources. As a result, large new sources of air emissions fall within the scope of New Source Review (NSR) regulation, which requires that the emissions they produce be offset through the purchases of emission reductions from other existing sources.[193]

State regulatory authorities noted that electricity generation in other States causes pollution that crosses State boundaries. Thus the State considered these emissions too. The Commission directed (in Decision 91-06-022) that the utilities' base case analysis assign a uniform value to residual emissions, regardless of where they occurred, based on the marginal cost of emission control. However, in a subsequent decision, the CPUC shifted from uniform to nonuniform residual emissions valuation and stated that the base case should value emissions depending on where those emissions were generated.[194] Emissions in nonattainment areas would be valued using the marginal cost of control, but emissions in attainment areas would use values adopted by the Nevada Public Service Commission. The CPUC directed Pacific Gas and Electric to use a combination of the South Coast Air Quality Management District's (SCAQMD) values and values from the Pace (1990) study.[195]

Legislative enactments in California also require that resource acquisition explicitly recognize environmental and fuel diversity of renewable energy resources.[196] Thus, the CEC directed and the CPUC decided to set aside a portion of generating capacity for renewable resources in the recent bid solicitation. All technologies were allowed to bid against renewable "Identified Deferrable Resources," but at least half the capacity was to be awarded to bidders using renewable energy sources.[197]

[193]Air emissions and impacts of power plants built before the mid-1970s are controlled through local Air Quality Management District retrofit regulations and other local regulations. However, plants built between the mid-1970s and the mid-1980s were subject to less restrictive environmental controls. Problem areas, therefore, remain.

[194]California Public Utilities Commission, Interim Opinion, *Resource Plan Phase: Bidding for New Generation Resources*. Decision 92-04-045 with respect to Docket No. I.89-07-004 (filed July 6, 1989).

[195]Pace University Center for Environmental Legal Studies, *Environmental Costs of Electricity* (Oceana Publications, Inc., New York, NY, 1990).

[196]California Assembly Bills 2198 and 1090.

[197]In 1985, the CPUC adopted the concept of using utilities' resource plans as the basis for setting longrun avoided costs. Cost-effective resource additions identified in a utility's resource plan could be deferred (or avoided by qualifying facilities) and the longrun avoided cost prices paid to these qualifying facilities could be based on the cost of the generation resource that was deferred. These resources came to be known as "Identified Deferrable Resources" or IDRs. See California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October, 1993), p. 4.

Alternative Approaches to Treatment of Externalities

In recent testimony before the CEC, the Commission Staff stated that the overall impact of externality considerations had not been significant.[198] With a view to overcoming the prevailing shortcomings in using externality values, the CEC Staff recommended consideration of the following five alternatives:[199]

a. Improved damage assessment and translation

b. Multi-attribute tradeoff analysis

c. Environmental performance standards

d. Marketable permit programs

e. Emission taxes and surcharges.

Of the above alternatives, the first two require improvements or refinements in current practices.[200] The third offers the possibility of developing a flexible policy for implementation.[201] The last two approaches are market-oriented. Among these alternatives, the CEC Staff prefer market-based options such as permits and surcharges. However, they suggest that second-best measures such as standards are appropriate interim measures.[202]

The electric utilities in the State point out that not all emissions are attributable to them and that a significant share comes from other sources not subject to regulation. As an example, Pacific Gas and Electric (PG&E) indicated that electric utilities emit only 3 percent of Statewide NO_x emissions. With improvements in technology, utility NO_x emissions have declined further and are expected to be about 1 percent by the year 2002.[203] The utility argued that any further attempt to reduce utilities' NO_x emissions would be inefficient.[204]

Some participants at a workshop convened by the CEC stated that the air quality standards in California would continue to improve as a result of air quality regulations requiring cleaner electricity generation. In their view, establishment of market-oriented systems might offer a better approach than internalization. Based on these considerations, the "benefits of substantial additional attention to internalizing remaining electric utility emissions may not be worth the associated cost."[205]

The CEC Staff recognize the range of problems associated with internalizing externalities. Plans for the future include a reexamination and improvement of the implementation procedures while continuing to recommend minimizing social cost as an appropriate goal even as the industry structure changes. The possibility that moving to a more competitive structure in the electric power industry will limit the means of energy regulatory agencies to internalize externalities has also been noted. As a result, the CEC Staff has called for the Legislature to establish a collaborative task force to examine externalities in a restructured electricity industry.

Externality Values Adopted by California

Externality values for five major air pollutants associated with electricity generation were established in California (Table 14).[206] These values are based on the estimates of the marginal cost of the best available control technology. The externality values differ among regions in the State depending on whether a given region is in attainment with the required air quality

[198]California Energy Commission, *Staff Testimony on Internalizing Externalities*, Docket No. 93-ER-94 (Sacramento, CA, October 20, 1994).

[199]California Energy Commission, *Staff Testimony on Internalizing Externalities*, Docket No. 93-ER-94 (Sacramento, CA, October 20, 1994).

[200]The first two methods have been discussed in Chapter 3.

[201]For additional details on this approach, see The National Regulatory Research Institute, *Public Utility Treatment of Environmental Externalities* (Columbus, OH, June 1994).

[202]Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

[203]Rebuttal Testimony submitted by Pacific Gas and Electric Company on November 3, 1994, regarding the *Preparation of the 1994 Electricity Report (Docket No. 93-ER-94)*, to the California Energy Commission, Sacramento, CA.

[204]San Diego Gas & Electric argued for considering externalities in the siting process, not in the planning process, so as to allow competition to be unfettered. However, CEC Staff cautioned against confusing externalities with environmental impacts, and it was unclear to CEC how externalities would be addressed in siting.

[205]California Energy Commission, *Staff Testimony on Internalizing Externalities*, Docket No. 93-ER-94 (Sacramento, CA, October 20, 1994).

[206]Note that residual emissions remain after an electric generation plant has met all applicable air quality requirements and that these residual emissions continue to impose a cost on society. A reduction in the level of residual emissions provides a net benefit to society.

Table 14. Externality Values for California
(1992 Dollars/Ton Emission)

Pollutant	Southern California Edison	San Diego Gas & Electric	Pacific Gas & Electric	Areas in Attainment
NO_x	31,448	31,448	9,120	7,467
SO_x	23,490	23,490	4,486	1,720
PM_{10}	6,804	6,804	2,624	4,608
ROG	22,462	22,462	4,236	1,301
CO_2	9	9	9	9

NO_x = Nitrogen oxides.
SO_x = Sulfur oxides.
PM_{10} = Particulate matter less than 10 microns in diameter.
ROG = Reactive organic gases.
CO_2 = Carbon dioxide.
Source: Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

standards. Inclusion of carbon dioxide value hinges on perceptions of the need to control future risks of regulation.

It may be noted that the CEC offers guidance on the values to be used in each Biennial Update.[207] In the *1992 Electricity Report* and the *Draft Final 1994 Electricity Report*, the damage function approach was used as the appropriate methodology for estimating values of residual pollutant emissions from power plants.[208] In recent testimony, the CEC Staff recommended residual emission values for use in the forthcoming *1994 Electricity Report.*[209] In addition, the CEC provides information on values to use for out-of-State residual emissions. Note that the CEC's recommendations are not binding. The CPUC, therefore, makes its own determination. Comparison of externality values in Tables 12 and 13 shows differences in the valuations of the CEC and the CPUC.

The Integrated Resource Planning Process and the Biennial Resource Planning in California

In July 1989, the CPUC designated the Biennial Resource Plan Update (BRPU) as the forum in which it would address issues related to longrun avoided cost and resource planning and acquisition.[210] The BRPU has three main goals:[211]

- To identify the total need for new generation capacity for each of the three participating electric utilities in the State, i.e., Southern California Edison, San Diego Gas and Electric, and Pacific Gas and Electric
- To quantify the capacity that qualified facilities (QFs) may potentially supply

[207]The Biennial Resource Planning requires the utilities in California to submit plans every 2 years identifying the need for new generation capacity within the prevailing regulatory framework in the State. See California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993).

[208]The Air Quality Valuation Model (AQVM) developed by the CEC is used to assist in developing appropriate values. The AQVM uses the damage function method to calculate the damage associated with residual air emissions in various locations/regions. The model requires two inputs, the geographical area of interest and the energy technology to be evaluated. The first determines baseline air quality, and the second determines several characteristics like emission factors, stack height, exit temperature, and velocity. The AQVM also uses the Environmental Protection Agency's *Empirical Kinetic Modeling Approach (EKMA)* for ozone modeling. See California Energy Commission, *The Air Quality Valuation Model* (Sacramento, CA, April 1994).

[209]California Energy Commission, *Valuing Residual Pollutant Emissions*, Docket No. 93-ER-94, July 27, 1994.

[210]California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993), p. 3.

[211]California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993), p. 3.

- To establish reasonable prices and terms for energy and capacity from the QFs.

The starting point for each BRPU cycle is the release of the *Electricity Report* by the CEC. The *Electricity Report*, released biennially, contains resource plans responsive to the State's longrun electricity policy.[212] On the basis of the CEC's demand and supply assumptions, the investor-owned utilities submit resource plans to the CPUC. In making their submissions, the utilities ensure that they meet CPUC's cost-effectiveness test stipulations.[213]

The next step is for the CPUC is to hold hearings permitting interested parties to present their comments and suggest alternatives. At the conclusion of the hearings, the CPUC makes a determination of the total resource needs for each utility. At the same time, the CPUC makes a distinction between deferrable and nondeferrable resource needs.[214] The CPUC's decision also specifies a certain amount of capacity and corresponding benchmark prices to be offered for possible deferral through bidding by qualifying facilities.

The final step involves the utilities' bid solicitation and the QF auction process.[215] The utilities issue a "Request for Bids" detailing the particulars of the identifiable deferrable resources and the availability of longterm standard offer contracts based on the capacity and the fixed and variable cost of the avoidable resource(s).[216] From the date of the release of the CEC's *Report*, length of an average cycle is about 3 years (Figure 3). The procedural steps are discussed next.

Environmental externality considerations are included in the QF purchases as a part of the contract modification. Since the emissions from an identifiable deferred resource (IDR) are known, they can be easily estimated. Based on these estimates, the QFs receive "adder" or "subtractor" payments (at the time of acquisition) based on the net difference in emissions between the QF and the IDR. Emission costs from all new resources, whether utility resources or QF resources, are calculated by multiplying the emissions values by the amount of residual emissions. The position of the CEC and the CPUC is that new coal-fired plants have no role in resource plans in California at this time.[217]

In addition to a consideration of the environmental impacts of new resources on air emissions, the CPUC also requires that a specific portion of future generating capacity be set aside for renewable resources.[218] The amount of capacity to be set aside is decided on a utility-by-utility basis as a function of the diversity in the utility's existing resources. Benchmark prices for renewable set-asides are established by the cost of the

[212]The *1992 Electricity Report*, for example, addressed the following major issues in its discussion of the State's resource needs: incorporation of environmental concerns in resource planning, problems with State's resource planning and acquisition process, potential changes in long-term trends in electricity demand, natural gas supply and price risks, future role of energy efficiency, potential benefits of advanced and noncommercial generation options, the future role of renewable technologies, and the effects of changes in transmission system regulation on longrun electricity planning. Refer California Energy Commission, *The Electricity Report, 1992* (Sacramento, CA, January 1993), p. 2.

[213]The cost-effective test methodology adopted by the CPUC is known as the Iterative Cost-Effective Methodology (ICEM). The ICEM is used to identify the type, size, and timing of the utility's most cost-effective resource addition in relation to its overall system cost. California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993), p. 4.

[214]Deferrable resources include baseload or intermediate load resources that appear in the first 8 years of the planning horizon. The time period represents the leadtime necessary for utility power plants. Nondeferrable resources consist of peaking units, short-run capacity, demand-side management resources, committed resources, and others. See *California Public Utilities Commission, Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993), p. 4.

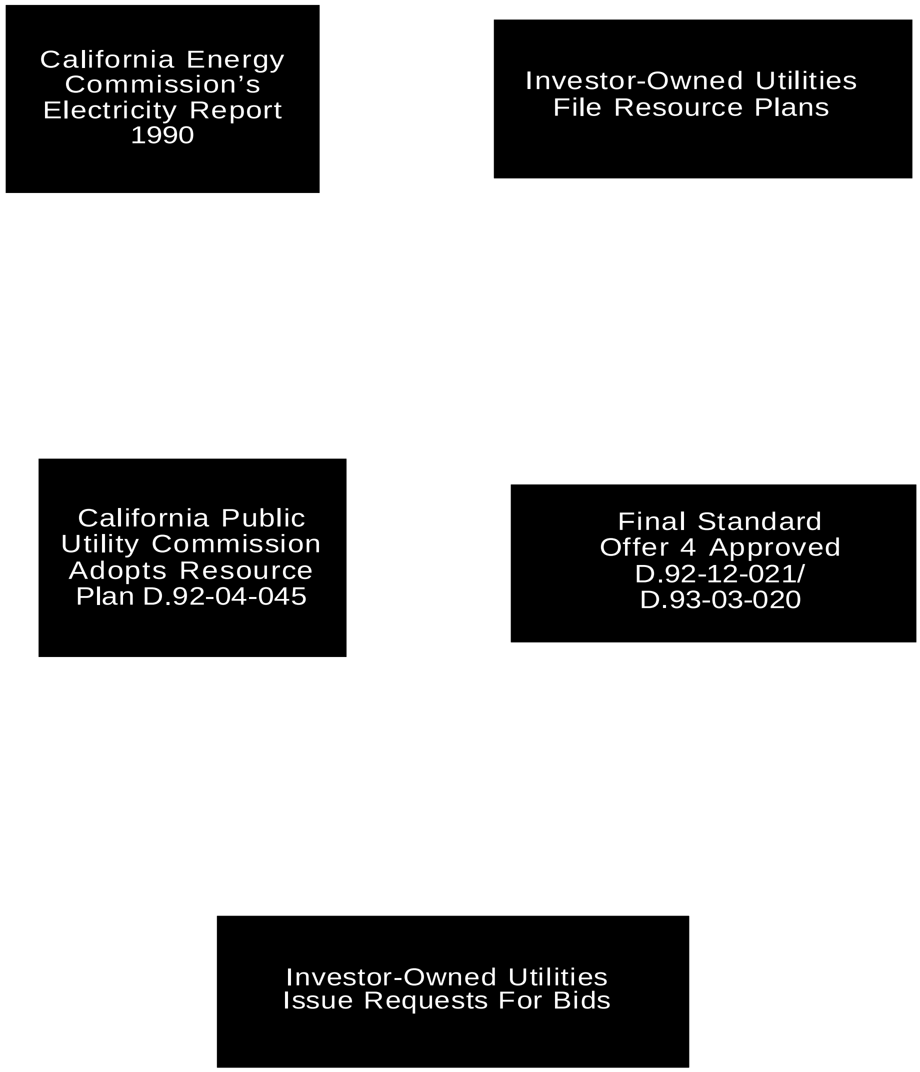
[215]In the early 1980s, the CPUC implemented provisions of sales (implicit in the PURPA legislation) via a series of four preapproved power purchase contracts called "Standard Offers." The Standard Offers 1, 2, and 3 are shortrun in terms of which the QFs receive prices based on utilities' existing generation resources. Interim Standard Offer 4 is longrun in which prices are based on the costs of new generation resources that the utility avoids by the QF purchase. These procedures for pricing QF purchases led to an oversubscription of purchases from QFs in the 1980s. With a view to correct and modify this situation, the CPUC formulated what is now called the *Final Standard Offer 4 or FSO4.* The FSO4 represents a shift toward a market-oriented policy.

[216]Utilities' resource plans are used as the basis for setting longrun "avoided costs." The QFs' initial attempt is to make an offer at a price which is equal to or lower than the utilities' avoided costs. Provisions also exist for a second price auction where the QFs compete on the basis of price. In this approach, the incentive for a QF is to quote its own marginal cost rather than the avoided cost of the utility even though it may receive a market clearing price which may be higher than its own marginal cost. For additional details see California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993), p. 5.

[217]Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

[218]This requirement has been mandated by Assembly Bill 1090 passed by the California Legislature in 1991. The requirement to set aside a portion of the capacity for renewables will remain in force until such time that electrical generating methodology valuing environmental and diversity costs and benefits is completed.

Figure 3. Biennial Resource Plan Update: Timing of Significant Events



Source: Adapted from California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993).

IDRs and are subject to the requirement that the winning QF's total cost should be lower than cost of the IDR.[219]

Pacific Gas and Electric's Considerations of Externalities in its Resource Planning

Pacific Gas and Electric's 1994 Integrated Resource Plan

The electric resource plan submitted in 1994 by Pacific Gas and Electric (PG&E) has the following three main ingredients:

- Demand-side management will continue to be the cornerstone of PG&E's resource planning during the 1990s.

- Economic upgrades, license extensions, and environmental retrofits at PG&E's existing facilities will be undertaken to permit an efficient use and maintenance of existing resources.

- Flexible new contracts in the wholesale market will be undertaken so that the entry of "exempt wholesale generators" as envisaged in the Energy Policy Act of 1992 can be accommodated.

PG&E is the nation's largest investor-owned utility, serving nearly 13 million customers. Its diverse mix of plants includes nuclear, natural gas, hydroelectric and pumped storage, and geothermal power plants. Taken together, these plants account for nearly 15,000 MW of summer and winter capability. In addition, nonutility generators contribute about 2,850 MW of on-peak dependable capacity using cogeneration, wind, solar, and biomass.

Output from the utility's above facilities supplemented by inter-utility purchases/imports enabled PG&E to meet its planning area load of 88,000 gigawatthours in 1993.[220] Table 15 shows the percentage breakdown of electricity sources for 1993 and projections for the year 2004.

PG&E projects that for the next 10 years, demand-side management programs will be the primary providers of additional capacity to meet the system load. Starting in 2002, the utility will require purchases of wholesale generation: 320 MW in 2002, growing to 1,340 MW by 2004.

Based on the above considerations, PG&E's most likely forecast shows need for new supply-side resources of

Table 15. Sources of Electric Energy for Pacific Gas and Electric (PG&E)
(Percent)

Sources	Actual 1993	Projected 2004
Purchases From Current or Committed Qualifying Facilities	25	22
New Wholesale Purchases	NA	3.5
PG&E Fossil (Natural Gas)	22	20
Nuclear	19	14
PG&E Hydro	16	12
Government Hydro	6	11
Geothermal	7	3
Imports (Primarily From the Northwest)	5	11
New Demand-Side Management Programs	NA	3.5

NA = Not applicable.
Note: PG&E has hundreds of contracts with qualifying facilities. Qualifying facilities use cogeneration, wind, solar, and biomass.
Source: Pacific Gas and Electric Company, *1994 Electric Resource Plan* (San Francisco, CA, 1994).

[219]For additional conditions regulating these requirements, see California Public Utilities Commission, *Biennial Resource Plan Update: A Primer* (San Francisco, CA, October 1993), p. 7.
[220]The data have been abstracted from PG&E's *1994 Electric Resource Plan* submitted to the CPUC.

about 320 MW in 2002, increasing steadily to about 3,700 MW by 2010.[221] For the years 1993 and 2004, the impact of these resource changes on sources of electricity can be seen in Table 15.

Impact of Externality Considerations on Pacific Gas and Electric's Resource Mix

The Pacific Gas and Electric (PG&E) company used a specific set of values (Table 16) to assess the impact of the externality values on its mix of resources. These values were used in the utility's most recent resource planning submission to the CPUC and were based on the values provided by the CEC in the *Draft Final 1994 Electricity Report*.

Inclusion of externality values accelerates the shift from new combustion turbine units to combined cycle units (Table 17).[222] Other than this timing shift, there are no other changes in resource acquisition plan or in the mix of resources to be acquired. In particular, the externalities values have no impact on the amount of nonfossil and demand-side resources because they are not options that the utility considers in its analysis.[223]

The existing resource mix of the PG&E may be a part of the reason why there is a lack of impact on resource acquisition even when externalities are internalized. Current externality considerations apply primarily to residual air emissions. In 1993, more than 90 percent of PG&E's fossil-fueled generation used natural gas. Internalizing externality values is not likely to take away the advantages of natural gas as a clean fuel. Furthermore, the prevailing low gas prices preclude other technologies with lower emissions from being cost-effective.[224] In any case, these considerations do not affect PG&E's acquisition plans.

Concluding Remarks on the Impact of Internalization Efforts on Resource Acquisition in California[225]

The CEC Staff recently provided an assessment of the status of internalization efforts in California with specific reference to impacts on actual procurement and operations decisions by the utilities.[226] While recognizing that the "efforts to identify externalities, estimate their damages or benefits have continued and improved over time, the record of applying the damage function

Table 16. Externality Values Used by Pacific Gas and Electric Based on Values Estimated by the California Energy Commission for the 1994 Biennial Update
(1996 Dollars/Ton Emission)

Pollutant	San Francisco Air Basin	South Central Coast Air Basin	North Central Coast Air Basin	Out-of-State Northwest
Nitrogen Oxides	7,000	1,676	1,018	292
Sulfur Oxides	15,660	4,060	2,640	298
Particulate Matter Less Than 10 Microns	23,760	6,920	7,020	556
Reactive Organic Gases	204	44	34	0
Carbon Dioxide	9.82	9.82	9.82	9.82

Source: Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

[221]Note that the utility used the Iterative Cost-Effectiveness Methodology (ICEM) model to develop a least-cost plan. The utility presented a base case plan and an alternative case using residual emission externality values. The utility then applied a three-step uncertainty analysis to both plans before deciding that the base plan was its preferred plan. The uncertainty analysis used ranges of load growth and fuel prices.

[222]Due to modeling limitations, PG&E considered only NO_x, PM_{10}, and CO_2 externalities in the numerical analysis.

[223]Since PG&E *assumed* that all new resources would be gas units, the externality values had little effect on the mix of resources (i.e., they only effected a more rapid shift from combustion turbine units to combined cycle units).

[224]There are problems in controlling emissions attributable to QFs or to out-of-State purchases.

[225]As defined by the CEC, internalization connotes "policies, such as emission taxes or permit markets, that affect the cost of activities producing externalities as to equate the marginal social cost of the activity with the marginal social benefit." California Energy Commission, *Staff Testimony on Internalizing Externalities,* Docket No. 93-ER-94, September 15, 1994.

[226]California Energy Commission, *Staff Testimony on Internalizing Externalities*, Docket No. 93-ER-94 (September 15, 1994, and October 20, 1994).

Table 17. Pacific Gas and Electric's Analysis of the Effects of Externality Values on Resource Additions

Year	Spot Purchases (megawatts)	BPA Exchange (megawatts)	Additions *WITHOUT* Consideration of Externalities			Additions *WITH* Consideration of Externalities		
			101.5 MW Combustion Turbine Units	215 MW Combined Cycle Units	Total MW Added	101.5 MW Turbine	215 MW Combined Cycle Units	Total MW Added
1994	0	0	0	0	0	0	0	0
1995	200	300	0	0	500	0	0	500
1996	200	300	0	0	500	0	0	500
1997	200	300	0	0	500	0	0	500
1998	200	300	0	0	500	0	0	500
1999	200	300	0	0	500	0	0	500
2000	200	300	0	0	500	0	0	500
2001	200	300	0	0	500	0	0	500
2002	200	300	0	0	500	0	0	500
2003	200	300	5	0	1,008	3	2	1,235
2004	200	300	12	0	1,718	10	2	1,945
2005	200	300	17	1	2,441	11	4	2,477
2006	200	300	17	4	3,086	11	7	3,122
2007	200	300	17	5	3,301	11	8	3,337
2008	200	300	17	7	3,731	11	10	3,767
2009	200	300	17	9	4,161	11	12	4,197
2010	200	300	17	10	4,376	11	13	4,412
2011	200	300	17	13	5,021	11	16	5,057
2012	200	300	17	16	5,666	11	19	5,702

BPA = Bonneville Power Authority.
Source: Pacific Gas and Electric, *1994 Electric Resource Plan*, submitted to the California Public Utility Commission.

methodology and results to electricity system procurement and operations decisions is at best problematic. The uncertainties involved in the analysis of externalities combined with inherent difficulties of regulatory coordination and scope have been found to limit the translation of identified social benefits of accounting for externalities from system planning results through procurement decisions into operational reality."[227] In other words, incorporating externality values in the resource selection process had only a small or negligible impact on actual procurement and operation decisions as developed by the investor-owned utilities and/or approved by the CPUC.

The Staff's discussion of the above results does not take into account factors like the lack of supply-side capacity requirements by the investor-owned utilities or the decline in natural gas prices but focuses on problems of regulatory scope in the State. First, coordination difficulties between the electricity resource planning process (initiated by the CEC) and the utility capacity procurement process (controlled by the CPUC) are identified as inhibiting achievement of planned goals. Limited authority enjoyed by the planning and procurement regulators, i.e., the CEC and the CPUC, precludes coordination with other State regulatory agencies and out-of-State authorities. Second, the current planning process does not take into account externalities from other energy sectors. Third, the differential treatment of externalities in the regulatory process encourages short-term acquisition of resources from the spot market or the nonutility generators which are not

[227]California Energy Commission, *Staff Testimony on Internalizing Externalities*, Docket No. 93-ER-94 (October 20, 1994), p. 2.

subject to the same externality considerations. Finally, there are uncertainties involved in developing estimates of the value of reducing externalities from power plant residual emissions.

The CEC Staff recognized that the problems of coordination and uncertainty are not easy to eliminate even though some improvements may be possible. Procedures to translate planning-oriented benefits (from internalization of externalities) into reality should be re-examined and improved. The Staff also recommended that the CEC request the State legislature to enact changes that would permit internalization of externalities even as the industry structure changes.

It should also be noted that the acquisition of resources under the current Biennial Update has been suspended due to litigation. The Federal Energy Regulatory Commission (FERC) overturned CPUC's procurement process in February 1995 on the grounds that it had violated the Public Utility Regulatory Policies Act of 1978 in calculating avoided costs for the Biennial Resource Plan Update by failing to take into account all resources available to the State's utilities and by allowing only QFs to bid. CPUC considered whether to take FERC to court to resolve the issue. Southern California Edison had also been litigating against the auction process for some time. In response to these pressures, the CPUC declared in July 1995 that the auction process implicit in the Biennial Resource Plan Update was annulled.[228]

These developments, however, do not affect the general conclusion about California's experience. Overall, California's decision on the use of externality values has not had any effect on the mix of resources to date. Furthermore, with industry restructuring afoot, the attention of CPUC and the industry is directed at reducing private costs, without any consideration of externalities. On this issue, the CEC and the CPCU may differ.

[228]*Electric Power Alert*, July 19, 1995, p. 8.

7. Externalities in a Changing Industry Environment

The 2 decades from the early 1970s to the early 1990s witnessed a phenomenal growth in delineating the environmental impacts of electricity generation. Studies detailing the various approaches to handling and quantifying environmental costs of electricity proliferated.[229] More recent studies attempt to encapsulate the totality of environmental impacts stemming from the current modes of energy production and consumption activities.[230] In addition, growing national and international environmental concerns (attributable to energy consumption) have brought about a nexus between environmental and energy issues.

Although the adverse environmental impacts of energy consumption in general and electricity generation in particular have been duly recognized, there is still no consensus on methodological approaches to be used in quantifying environmental costs. Agreement concerning the incorporation or internalization of the adverse environmental impacts of electricity generation in market-pricing calculations is rather limited in its scope and applicability.

Externality Considerations Within the Integrated Resource Planning Framework

Federal and State regulations, taken together, govern the environmental aspects of electricity generation in the United States. Most Federal regulations mandate requirements that need to be met within a specified timeframe. Capital, operating, and maintenance costs of meeting federally mandated environmental standards are thus internalized and reflected in the rates customers pay for the electricity they buy.

The Appendix summarizes the States' activities with respect to handling externalities. Note that more than half the States currently require that environmental externalities be considered in some form or the other. However, some States still have no plans to incorporate externalities in their rulemaking procedures. In short, the treatment of externalities at State levels is asymmetrical ranging from environmental zeal to inertia or benign neglect.

Of the States requiring utilities to consider externalities quantitatively, only seven—California, Massachusetts, Minnesota, Nevada, New York, Oregon, and Wisconsin—specify monetary values by emission (Table 18).[231]

The States that form the subject of this study—Massachusetts, Wisconsin, and California—were selected from the group of seven States that have specific monetary values for externalities. Apart from being in the vanguard of incorporating monetized externality values, the choice of these States reflects a regional diversity.

In each of the above three States, the externality values were used within the framework of the integrated resource planning process. Externality values, as specified for designated emissions or pollutants, are required to be applied in the utilities' evaluation of procured energy and demand-side resources as well as any new capacity requirements. Thus, the externality values were factored in (assuming them to be a resource cost) in selecting future resource options within the integrated resource planning process. Incorporating externalities within the integrated resource planning process could affect two basic types of utility decisions: resource planning decisions and system operation decisions (Figure 4). Resource planning decisions include: building new plants or purchasing power from nonutility generators; undertaking life-extension/repowering; and postponing the need for new capacity by implementing demand-side management programs. System operation decisions are those that involve the order in which the utilities commit units and dispatch them to meet load. "Adders" could be applied to more polluting units, permitting the functioning of what is called an

[229]For an excellent overview of the recent relevant studies, see U.S. Congress, Office of Technology Assessment, *Studies of the Environmental Costs of Electricity,* OTA-ETI-134 (Washington, DC: U.S. Government Printing Office, September 1994).

[230]Oak Ridge National Laboratory and Resources for the Future, *U.S.-EC Fuel Cycle Study: Background Document to the Approaches and Issues, ORNL/M-2500* (Oak Ridge, TN, November 1992).

[231]Massachusetts will not be able to incorporate externality values as a result of the decision by the State's Supreme Court on December 22, 1994. See Chapter 4 for more information.

Table 18. Externality Values for Different Pollutants, by State
(1992 Dollars/Ton)

State	Pollutant					
	SO_2	NO_x	TSP or PM10	VOCs	CO_2	CO
California	4,486	9,120	4,608	4,236	9	NVS
Massachusetts[a]	1,700	7,200	4,400	5,900	24	960
Minnesota	150	850	1,274	1,190	9.8	NVS
Nevada	1,716	7,480	4,598	1,012	24	1,012
New York	1,437	1,897	333	NVS	1	NVS
Oregon	0	3,500	3,000	NVS	25	NVS
Wisconsin	NVS	NVS	NVS	NVS	15	NVS

[a]Massachusetts will not be able to incorporate externality values due to a decision by the State's Supreme Court on December 22, 1994.

CO_2 = Carbon dioxide.
NO_x = Nitrogen oxides.
SO_2 = Sulfur dioxide.
NVS = No value stipulated.
CO = Carbon monoxide.
PM10 = Particulate matter less than 10 microns in diameter.
TSP = Total suspended particulates.
VOC = Volatile organic compounds.

Notes: Not all pollutants are included in this table. For example, methane and nitrous oxide are not included. Median values are given if the State has a range of values.

Source: Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

"environmental dispatch." Adoption of environmental dispatch may, however, bring about other changes for which the industry may not be fully prepared.[232]

The Impact of Incorporating Externalities on the Resource Mix of Utilities

The analyses presented in the preceding three chapters show that even though each of the States required incorporation of externality values in planning for resources, the valuations and the emphasis varied significantly. Wisconsin, for example, focused exclusively on greenhouse gas emissions. Massachusetts and California had varying values for residual emissions in addition to values for some or all greenhouse gas emissions.[233] In seeking the incorporation of externalities, the States concentrated on directing the resource selection process within their own geographic areas. Prescribed externality values were used for purposes of making a comparative assessment of resources to be acquired to meet future needs of the regulated utilities.[234]

Incorporation of externalities in the three States had little impact on the resource selection process in a conventional sense. With a continuing softness in the price of fossil fuels since the early 1980s, combined with advances in technology, natural gas emerged as the fuel of choice in most resource selections determined by considerations of cost effectiveness.[235] Accordingly, where the alternative modes of generation did not show a cost advantage, no perceptible impact on the mix of resources is observable. In addition:

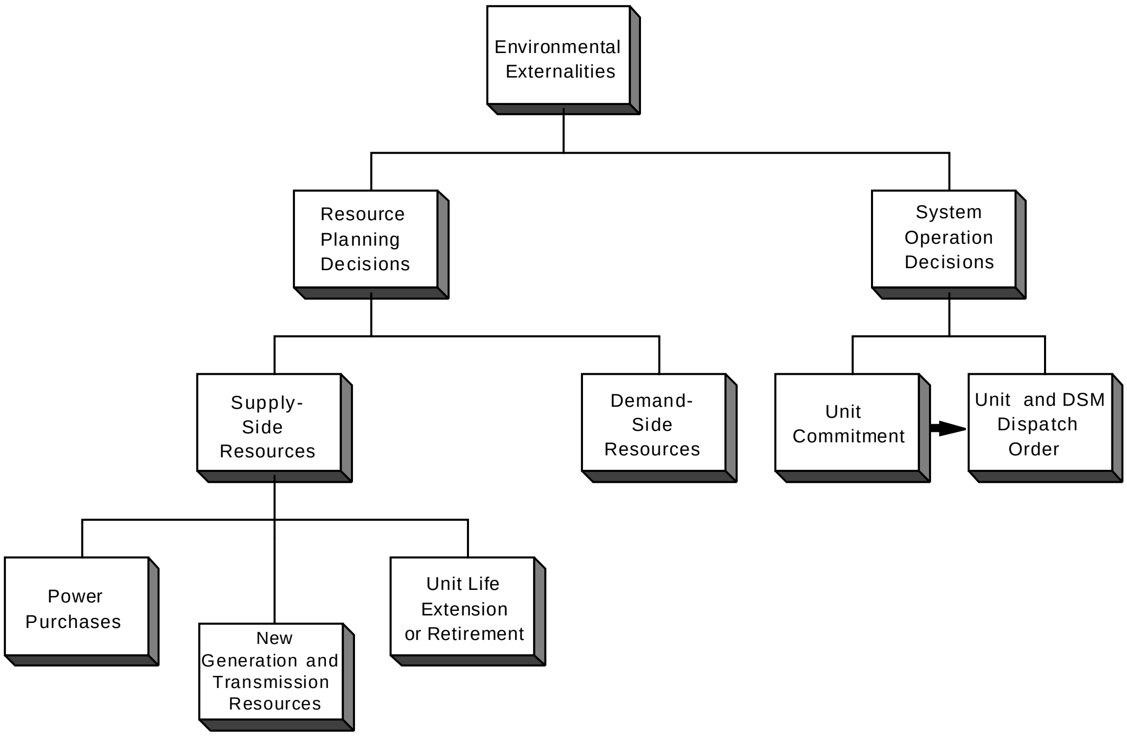
[232]For example, if "adders" are to be levied on old coal units, the results may be to change the dispatch order, resulting in cycling rather than a baseload operation, lower capacity factor, and reduced emissions. See Research Triangle Institute, *Accounting for Externality Costs in Electric Utility Planning in Wisconsin* (Research Triangle Park, NC, November 1991), p. 2-4.

[233]Note that the revised integrated resource planning in Massachusetts no longer requires the consideration of externalities. In California, the current restructuring debate is critical.

[234]California incorporated considerations for purchases from out-of-State as well.

[235]The annual average wellhead price for natural gas declined from a 1983 peak of $2.97 per thousand feet to a 15-year low of $1.39 per thousand feet in 1991. Prices recovered somewhat over the next 2 years, reaching $1.59 per thousand cubic feet in 1993. Per barrel crude oil refiner acquisition costs declined from $44.66 in 1981 to $13.21 in 1993. Finally, delivered coal prices to the electric utilities declined from a high of $41.66 per short ton in 1982 to $23.06 per short ton in 1993. Note: all prices are expressed in constant 1987 dollars. Energy Information Administration, *Annual Energy Review 1993*, DOE/EIA-0384(93) (Washington, DC, July 1994).

Figure 4. Utility Decisions That Could Be Affected by Considering Environmental Externalities



DSM = Demand-side management.
Source: Research Triangle Institute, *Accounting for Externality Costs in Electric Utility Planning in Wisconsin*, RTI Project No. 354-5198-01.DR (Research Triangle Park, NC, November 1991), p. 2-2.

- No renewable energy technology was selected as a result of calculations using the prescribed externality values in any of the three States.[184]

- Resources becoming available as a result of implementation of demand-side management initiatives were largely unaffected by externality considerations.[185]

- Shifts in timing of certain natural gas plants coming online could be viewed as an impact.[186]

Two other recent studies reach similar conclusions.[187] A study undertaken by the Oak Ridge National Laboratory states that "no renewable energy project has been selected with externalities as the deciding factor."[188] A report by the General Accounting Office

[184]Penetration of renewables in electricity generation (in the past) is attributable to special programs such as Federally legislated requirements or State set-aside programs. The passage of the Public Utility Regulatory Policies Act of 1978 was another contributory factor in pushing the entry of renewables in electricity generation. See General Accounting Office, *Considering Externalities in Selecting Fuel Sources,* GAO/RCED-95-187 (Washington, DC, May 1995).

[185]Pacific Gas and Electric estimated a possible 5-percent increase in DSM activity when externality values were considered. Oak Ridge National Laboratory, *The Effects of Considering Externalities on Electric Utilities' Mix of Resources: Case Studies of Massachusetts, Wisconsin, and California* (Oak Ridge, TN, July 1995).

[186]The California Energy Commission makes a similar point by stating that "including residual emissions values accelerates the time when new resources become cost-effective and beneficial to society. The acceleration is generally modest." See California Energy Commission, *Draft Final 1994 Electricity Report* (Sacramento, CA, June 1995), p. 3-35.

[187]General Accounting Office, *Electricity Supply: Consideration of Environmental Costs in Selecting Fuel Sources*, GAO/RCED-95-187 (Washington, DC, May 1995), and Oak Ridge National Laboratory, *The Impact of Environmental Externality Requirements on Renewable Energy* (Oak Ridge, TN, December 1994).

[188]Oak Ridge National Laboratory, *The Impact of Environmental Externality Requirements on Renewable Energy* (Oak Ridge, TN, December 1994).

goes even further by stating that the consideration of externalities has not influenced the selection or acquisition of renewable energy or any other type of energy for electricity production. Reasons for the ineffective impact of incorporating externalities include:

- Requirements for additional supply-side resources are still years away with respect to the resource acquisition plans of all three investor-owned utilities analyzed in this report.

- A continuing decline in the price of fossil fuels tends to offset the cost-effectiveness of other generating options even when externality values are incorporated.

- Technological improvements and mandated emission controls with respect to fossil-fuel technologies may also contribute to restricting the operational impact of externality considerations.

- Investor-owned electric utilities lack adequate experience with emerging renewable energy technologies (other than hydropower) like solar, wind, and others.[241]

- Interjurisdictional issues make it difficult for utilities that operate in several States to choose renewable energy projects when the renewable technologies do not have a clear cost advantage.

- The level of externality values may not be high enough to mitigate cost advantages enjoyed by conventional technologies.

- There is an absence of enabling legislation to permit State regulatory authorities to enforce incorporation of externalities (as in the case of Massachusetts where litigation now precludes consideration of externalities).

Note should also be taken that utilities may differ in their interpretation of the decisions by the State regulatory authorities. For example, New England Electric in Massachusetts applied externalities to its "Green RFP" while the externality values used in the resource planning analysis were included only to provide information, not as a means of possibly altering the utility's resource mix. This point is, however, no longer relevant since the Massachusetts Supreme Court invalidated decisions of the MDPU with respect to incorporating externality values.

Externalities in a Changing Industry Environment

The domestic electric power industry has been undergoing changes, imperceptibly perhaps, since the mid-1970s. Oil price hikes, construction cost escalations, and higher-than-required excess capacity levels all contributed to the changes in one form or another.

Regulatory changes initiated by the Public Utility Regulatory Policies Act (PURPA) of 1978 accelerated industry changes. By permitting the entry of nonutility generators into the field of power generation, PURPA launched a process that facilitated penetration into the power generation monopoly enjoyed by the vertically integrated utilities. Subsequent enactment of the Energy Policy Act of 1992 has quickened the pace of transition and potential restructuring to a level (by fostering competition in the industry) that could not possibly be envisioned a few years earlier.[242]

Some State regulatory authorities have already initiated industry restructuring proceedings. For example, the California Public Utility Commission issued an order to institute investigation and rulemaking with respect to restructuring California's electricity industry in 1994.[243] Massachusetts initiated a similar proceeding earlier this year.[244]

A likely consequence of the restructuring would be the erosion of vertically integrated electric utilities with a significant dispersion of generation activities implicit in the unbundling of services concept.[245] With availability

[241]An additional problem is that not all renewables can generate electricity continually.

[242]Provisions of the Energy Policy Act of 1992 (EPACT) spur competition by creating a new category of power producers, called exempt wholesale generators. EPACT also requires all utilities that own transmission facilities to grant nondiscriminatory access to transmission grid and empowers the Federal Energy Regulatory Commission to ensure that utilities do provide this access.

[243]California Public Utilities Commission, *Order Instituting Rulemaking and Order Instituting Investigation, R.94-04-031 and I.94-04-032,* April 20, 1994.

[244]Massachusetts Department of Public Utilities, *Notice of Enquiry and Order Seeking Comments on Electricity Restructuring, D.P.U. 95-30,* February 10, 1995.

[245]The report does not discuss other consequences or ramifications of industry restructuring. It is, however, worthwhile noting that there will be significant changes to the ways in which the industry is regulated in the future.

of transmission access, the customers are expected to have the freedom to go to a supplier of their choice based on considerations of price and service.[246]

A dispersion of generation activities may imply fundamental changes in the exercise of regulatory oversight in the future. Some of the existing regulations may need to be modified, and some new guidelines may still be necessary. In this environment, State regulatory authorities may no longer be in a position to exercise control on acquisition of supply-side resources within the framework of what is now called the "integrated resource planning" process. The capability of States to enforce a consideration and incorporation of externalities—in the current mode—may no longer be feasible.

The California Energy Commission (CEC) acknowledges the potential impact of industry restructuring in many areas. The CEC, however, maintains that changes in the ownership of generating facilities (through sale or divestiture by the utilities) should not cause an increase in environmental damages and that future environmental regulations should be based on technology and performance rather than on ownership. Another recommendation is to increase the application of market-oriented internalization methods while continuing to use existing tools as new and changed methods are developed.[247] In Massachusetts, ongoing proceedings of the *Electric Industry Restructuring Roundtable* recognize the need toward environmental improvement based on retirements, replacements, controls, or offsets. The stated objective, however, is to find out "new innovative means to meet long-term environmental goals."[248] Additional details have not become available.

As restructuring progresses, issues other than environmental externalities may become more critical for the States' regulatory authorities. Issues connected with divestiture of the generation facilities, the handling of stranded investments, and transmission access and its pricing are possibly going to occupy the center stage in the near future. State regulatory authorities' primary concern will be to ensure reliability of services at reasonable prices for power. The possibility that environmental considerations by the States may thus be placed on the backburner is, therefore, not unlikely.

Even where the States manage to remain proactive in the handling of externalities, the impact scenario based on recent experience is far from encouraging. In addition, the State regulatory authorities can operate only within the State boundaries, whereas the environmental impacts of electricity generation inflict transboundary damages. Finally, energetic pursuit of handling externalities could, in theory, raise electricity prices higher than those prevailing in neighboring States (if they do not pursue a similar approach). The economic consequences of this disparity may imply that States may be reluctant to lose their competitiveness advantage.

Yet, the future may be less bleak than envisaged in the preceding paragraph. Innovative options for effectively treating externalities could still be found within an industry structure that may not be vertically integrated. For example, a nonbypassable wires charge could be used to fund energy efficiency investment by the local distributing company or to include other similar elements like externalities. It may also be possible to impose a higher cost on power purchases from "clean" sources.

A review of the recent State proceedings and other forums (such as the Electricity Forum sponsored by DOE and the National Association of Regulatory Utility Commissioners) indicates that there is considerable support for addressing "potentially strandable benefits" such as environmental protection, energy efficiency, and renewable energy. There is interest in explicitly designing environmental and other public interest considerations into the electric industry framework as is evident from the proceedings in Massachusetts and California. As a result, it may be difficult to predict the future of externality considerations in State settings.

[246]Vertically integrated electric utilities currently provide bundled services to their customers who treat and pay for electricity as a single, homogenous product. Their tariff structure bundles the cost of generation, transmission, distribution, and other ancillary services. Industry restructuring (in the future) may necessitate unbundling, implying a realignment of traditional assets currently included in the ratebase along functional lines. Realignment of assets may be through sale, segregation, divestiture, changes in corporate ownership or a shifting of assets outside the ratebase. Asset realignment may, therefore, lead to specific services being charged separately.

[247]California Energy Commission, *Draft Final 1994 Electricity Report* (Sacramento, CA, June 1995).

[248]Report by Eric Van Loon, Senior Mediator, *Electric Industry Restructuring Roundtable*, submitted to the Massachusetts Department of Public Utilities on July 17, 1995. D.P.U. 95-30.

Appendix

Summary of State Public Utility Commissions' Activities Regarding Externalities

Table A1. Summary of State Public Utility Commissions' Activities Regarding Externalities

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Alabama	None	Alabama does not require the inclusion of externalities in the Integrated Resource Planning (IRP) process.	There is no rule requiring that externalities be considered. Utilities generally address environmental concerns through regulatory compliance.	There are no plans to require that externalities be considered in the IRP process.
Alaska	None	In a recent case, the Commission affected an Order which states that, absent direction from the Legislature, the Commission will decline further consideration of environmental externalities in that case.	Given the legal uncertainties and the policy deviations inherent in consideration of environmental externalities, the Commission believes that the question of whether environmental externalities can be considered by the Commission should be addressed by the Legislature.	The Order is being appealed to the State Supreme Court.
Arizona	Developing	A 1992 Task Force report recommends that utilities determine quantitative estimates of externalities where possible, preferably based on damages and expressed as costs per unit of emission or per kWh, or develop multi-attribute assessments where monetization is not reliable or not applicable. The Task Force report also states that utilizing offsets is appropriate to the extent that they would not have otherwise occurred.	Environmental externalities are to be included as part of the total societal costs of meeting demand for electric energy services.	The Commission ordered staff to begin developing rules to incorporate the Task Force recommendations in the resource planning rules. A subsequent working group has recommended which externalities the rules should apply to. Workshops and hearings on the rule amendments were to be held in 1994.
Arkansas	Awareness	IRP guidelines include quantifiable avoided externality costs. While these guidelines provide guidance to utilities, no rule is in effect that *requires* them to include externalities in their resource planning.		There are no plans to incorporate externalities in any rulemaking.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
California	Operational	California requires that utilities consider quantitative estimates of externalities. Values are as follows: for Southern California Edison and San Diego Gas & Electric - \$31,448/ton NO_x, \$23,490/ton SO_x, \$6,804/ton PM_{10}, \$22,462/ton ROG, \$9/ton CO_2; for Pacific Gas & Electric - \$9,120/ton NO_x, \$4,486/ton SO_x, \$2,624/ton PM_{10}, \$4,236/ton ROG, and \$9/ton CO_2; for attainment areas- \$7,467/ton NO_x, \$1,720/ton SO_x, \$4,608/ton PM_{10}, \$1,301/ton ROG, and \$9/ton CO_2. All values are in 1992 \$. Offsets approved by the air quality district may be used.	Externality values are based on estimates of the marginal cost of the best available control technology. Different externality values are applied depending on whether the area is in attainment, and depending on the service territory. The California Energy Commission (CEC) also provides guidance on values to use for emissions experienced in-State and out-of-State. The CEC's recommendations are not binding.	The most significant development is the Commission's recent Order to institute investigation and rulemaking on a restructuring of California's electric services industry. The purpose of the proposal is to lower the cost of electric service in an increasingly competitive economic environment. The proposal calls for "retail wheeling" or "direct access" in which customers have the option of shopping around for the best deal. They would pay the local utility a retail wheeling rate for transmission and distribution services, and buy unbundled electricity generation service from any supplier. Under the proposal, environmental quality remains an important goal, but the proposal does not discuss the role of addressing externalities as a means of meeting those goals. Extensive hearings are being held on this proposal.
Colorado	Operational	Colorado requires qualitative, but not quantitative, consideration of externalities in utilities' IRPs. The General Assembly has also instructed that when the Commission considers environmental factors, it should also consider economic factors in its decisions.	Utilities are required to address externalities in their IRPs because Colorado is "not persuaded that mere compliance with existing environmental laws is equivalent to an absence of any externalities." The Order states, however, that methods for quantification are highly complex and speculative, and that given the current state of knowledge, it is premature to monetize externalities.	The Commission is unlikely to require quantification of externalities. In addition to its concern for the environment, the General Assembly is also concerned about economic factors and the health of the State's coal mining industry.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Connecticut	Operational	The Department recently issued its final report on the matter to the Legislature. In that report, the Department requires that, for all factors requiring internalization as a result of the Department's six-step screening process, utilities use tradeoff analysis. This analysis compares the costs of control under alternative scenarios with the quantified impacts of controls. This method was based on the Analysis Group for Regional Electricity Alternatives' (AGREA) approach, developed at the Massachusetts Institute of Technology. This approach uses graphs of compliance costs and emissions for different pollutants and for different technology options.	The Department requires that, where possible, externalities be quantified by weight or other nonmonetary measures. In its final report, the Department concluded that the use of monetized adders is highly subjective and is not appropriate.	In the future, utilities are expected to use the tradeoff analysis approach that the Department has adopted for any factor that requires internalization as determined by the Department's screening process.
Delaware	Operational	A Delaware Order requires qualitative, but not quantitative, consideration. Utilities must report how they consider and treat externalities in their IRPs.	This Order is in agreement with the Hearing Examiner's recommendation. The Commission has a public interest obligation to consider environmental factors.	There are no plans to re-open the matter, although the Hearing Examiner has indicated that a reconsideration might be made.
District of Columbia	Awareness	DC requires that "noneconomic factors are to be incorporated into the resource screening process but consideration of externalities is not formally ordered at this point."		No change is anticipated at this time.
Florida	None	Florida Power Plant Siting Board appointed a task force to draw up legislation based on the Department of Environmental Protection's recent report. The report states that externalities should be considered qualitatively in the power plant licensing process (i.e. on the choice of power plant). The Florida Legislature did not enact the legislation.	According to Florida's Department of Environmental Protection, use of quantitative values for environmental externalities is not practical now because there is no consensus that any set of values is accurate or wholly defensible.	The Florida Public Service Commission itself is not formally considering the issue. There are no dockets or rulemaking underway.
Georgia	Operational	Georgia requires quantification where possible and qualitative considerations in cases where quantification is not possible.		

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Hawaii	Operational	Hawaii requires quantitative consideration, if possible. If not, then externalities must be considered qualitatively.	Specified as part of Hawaii's IRP framework.	The current Order is the first that requires consideration of environmental externalities. Companies have been filing their IRPs. Hearings have been concluded on two cases, but no decision or order has been issued yet on either one.
Idaho	Awareness	Idaho's Least-Cost Planning Order does not have a formal requirement regarding externalities. Some statements in the Order suggest the desirability of hydro enhancements, but there are no generic statements about such a preference.		No quantitative consideration is expected soon.
Illinois	Operational	A statutory requirement necessitates qualitative and, if possible, quantitative consideration.	One of the goals of public utility regulation is environmental quality.	A rulemaking case is pending on how the Commission is to treat externalities, with hearings in the Spring of 1994. Two proposals are under consideration: (a) monetary adders for five specific emissions; and (b) cost of control for least-cost system-wide control of regulated emissions.
Indiana	None	Indiana does not require consideration.	Indiana is still in the process of developing resource planning guidelines.	There are no plans to include requirements regarding externalities as part of the forthcoming IRP rules.
Iowa	Operational	Iowa applies percent adders of 10 percent to avoided capacity and energy costs for electric utilities and 7.5 percent to avoided capacity and energy costs for gas utilities.	The calculations are part of an energy efficiency plan analysis in the State (essentially an IRP).	No change is anticipated.
Kansas	Developing	The commission has proposed IRP rules that require quantitative consideration to the extent feasible. Where externalities are not readily monetized, the proposal is that the utility consider them on a qualitative basis.		Hearings are being held on the proposed IRP rules and a final rule is expected soon.
Kentucky	Awareness	Kentucky does not require consideration.	There is no mention of externalities in Kentucky's IRP regulations.	Kentucky is monitoring developments in other States and elsewhere.
Louisiana	None	Louisiana does not require consideration.	Externalities are not an issue in the State.	No change is anticipated.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Maine	Developing	Maine does not require consideration, and is not actively developing requirements. A legislative initiative, however, requires the Commission and other State agencies to jointly investigate the externalities of energy production and consumption.		As part of the 2-year study required by the Legislature, the PUC and other State agencies are considering existing regulations, other States' actions, and methods of quantifying externalities.
Maryland	Awareness	Maryland does not have an Order that mandates the use of externality values. However, there are conservation collaboratives that develop avoided costs to value demand-side management, based on the system resources of the utility. In developing avoided costs, externalities associated with SO_2 and NO_x are considered both quantitatively and qualitatively. Other externalities are considered qualitatively. A 10-percent adder was recently used in one utility's demand-side management collaborative.		Utilities are increasingly concerned about the impacts of conservation programs on rates. These concerns are making it increasingly difficult to negotiate on environmental concerns.
Massachusetts	Operational	Massachusetts' decision requires quantitative consideration of externalities based on numbers the Commission adopted. The values are as follows: \$1,700/ton SO_x, \$7,200/ton NO_x, \$5,900/ton VOCs, \$960/ton CO, \$24/ton carbon dioxide, \$4,400/ton TSP, \$240/ton CH_4, and \$4,400/ton N_2O. These values are in 1992\$ and are based on control costs. Offsets will also be allowed where applicable. Utilities may use different numbers if they can demonstrate that the methodology used is as good as or better than the methodology used to determine the numbers above.	Utility resource decisions have a significant and lasting impact on the environment, and therefore, it is appropriate for environmental and utility regulators to establish policies so that environmental and economic objectives can be satisfied at least cost to society.	The Decision is under appeal before the Supreme Judicial Court of Massachusetts.
Michigan	Awareness	There is no explicit statutory requirement on externalities. Utilities assess the risk that externalities will need to be internalized at some point in the life of the plant.	Any direct requirement would be challenged by industry interests within the State.	No change is anticipated.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Minnesota	Operational	Minnesota issued an Order that sets "interim" values as follows: SO_2 0 - $300/ton NO_x $68.80 - $1,640/ton VOCs $1,180 - $1,200/ton TSP $166.60 - $2,380/ton CO_2 $5.99 - $13.60/ton	The values were determined by the Public Utilities Commission, taking into account the comments from all interested parties. The low end of the range for SO_2 assumed all costs to be internalized; the high end for SO_2 was based on current market price of emissions allowances. The values for NO_x, VOCs, TSP, and CO_2 are based on the recommendations of the Department of Public Services. The low end of the ranges are generally based on a study conducted by the Bonneville Power Administration (BPA), while the Pace study is the primary basis for the high end.	The Order on the interim values was just made in March 1994. Final values are to be decided later.
Mississippi	Awareness	Mississippi does not require consideration.		The issue may possibly arise when Mississippi Power & Light's IRP is taken up again.
Missouri	Operational	Missouri has an IRP Rule that requires utilities to assess the risk that externalities will need to be internalized at some point in the life of the plant. The analysis involves a three-step process that: (1) lists the pollutants that have some prospect of more stringent regulation in the future; (2) considers at least two levels of control and their subjective probabilities; and (3) computes the cost of the expected (i.e., average) mitigation.	Some sort of quantitative analysis seems necessary since decisions will have an impact on rates. However, the legislative mandate is not clear whether the Commission has the authority to require *direct* consideration of externalities. Also, the Commission considers the valuation of externalities to be highly uncertain given the state of the art and the great variation among States across the country.	The Public Service Commission is beginning to implement the process and the first of five utilities has filed.
Montana	Developing	Montana has IRP guidelines (though no order) for utilities to assess externalities and to account for them in their least-cost plans. The guidelines call for a range of estimates and their uncertainty, and for a consideration of the uncertainty and risk of future environmental regulations.	The Commission focuses on the integration of externalities when comparing options for resource acquisition.	In a recent cost of service and rate design docket, the Commission is scoping out the prospect of integrating externalities into the pricing of electric power.
Nebraska	None	Nebraska does not regulate electric utilities.	Nebraska is a public utility State. There are no investor-owned utilities.	

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Nevada	Operational	Nevada has a Rule that requires quantitative consideration of externalities. The values are as follows: \$1,716/ton SO_x, \$7,480/ton NO_x, \$1,298/ton VOCs, \$1,012/ton CO, \$24/ton CO_2, \$4,598/ton TSP, \$4,598 PM10, \$242/ton CH_4, and \$4,554/ton N_2O. These values are in 1992\$, based on the 1990\$ control-cost values given in the Rule. Utilities can use other values if they provide adequate justification.	The quantitative values were developed through a process that involved a series of public workshops. The 1990\$ values in the Rule are as follows: \$1,560/ton SO_x, \$6,800/ton NO_x, \$1,180/ton VOCs, \$920/ton CO, \$22/ton CO_2, \$4,180/ton TSP, \$4,180 PM10, \$220/ton CH_4, and \$4,140/ton N_2O.	No changes are anticipated at this time. The docket was reopened, but is closed without any changes affecting environmental considerations.
New Hampshire	Operational	While New Hampshire does not explicitly require consideration of externalities, a recent Order requires utilities to do a risk avoidance analysis that takes into account the risk of more stringent environmental regulations (and their subsequent costs).	The Commission is opposed to monetizing environmental impacts.	A group was formed among regulators in New Hampshire, Massachusetts, and Rhode Island to try to reach a regional consensus on how to address externalities. The group was unable to reach a consensus. For now, the Commission is focusing on the use of risk avoidance analysis to justify any premium above avoided cost.
New Jersey	Operational	A 2 cents/kWh (1991\$) credit is given to demand-side management (DSM) projects to reflect the reduction in externalities associated with electric power.	Part of the evaluation criteria for projects on the supply side are location and environmental benefits. On the demand side, the rationale for the DSM credit is the environmental benefit of energy conservation, as compared to supply-side resources.	Except for the DSM credit, other aspects are in a state of flux while the State works on developing its IRP process.
New Mexico	Developing	The Commission has issued a Notice of Proposed Rulemaking with respect to IRPs. The Notice refers to qualitative assessments of externalities.		The next step is to have hearings on the Notice of Proposed Rulemaking.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
New York	Operational	New York requires quantitative consideration based on values developed using control costs. Programs that promote energy conservation are credited with 1.4 cents/kWh. Following is the derivation of the maximum 1.4 cents/kWh credit: SO_2 0.250 NO_x 0.550 CO_2 0.100 Particulates 0.005 Water impacts 0.100 Land impacts 0.400 Total 1.405 These values represent the externalities attributed to each of the six sources of externalities, that are associated with a new coal plant that meets New Source Performance Standards (NSPS). Programs aimed at peak clipping are credited with 0.9 cents/kWh, and programs aimed at load shifting are credited with 0.04 cents/kWh. These latter values are based on residual environmental impacts of the resource relative to those of the NSPS coal plant.	State legislation requires that the State energy plan give due regard to environmental impacts. To estimate externalities, values based on the costs of control can be developed in a more straightforward way than damage-cost estimates.	The new State energy plan recommends a new set of values (levelized, nominal 1992$ per ton): SO_2 $1,367 NO_x $6,524 CO_2 $8.6 PM $3,642 VOC $4,400 Air toxics $164,000 CO $423 The State Public Service Commission may consider this recommendation in the near future. Also, a study is being conducted to develop a modeling system to calculate site-specific externality values. These values would be based on estimates of damages, rather than costs of control.
North Carolina	Operational	North Carolina requires qualitative consideration.	When demand and supply options have equivalent costs and reliability, the more benign resource will produce greater societal benefits.	The Commission has taken no further action beyond requiring qualitative consideration.
North Dakota	None	North Dakota does not require consideration.	The issue has not been considered.	The issue is unlikely to be considered by the State.
Ohio	Operational	Ohio requires utilities to use the value of under-utilization on a cents/kWh basis. For SO_2, the value of 0.04 cents/kWh is a benchmark, with acceptable values being in the range 0.03-0.05 cents/kWh.	Following the Clean Air Act Amendments, the Commission considered the constituents addressed in the Act, and decided that it was financially prudent not to require utilities to do their own research but rather wait for other reliable quantitative values to be developed. The value of 0.04 cents/kWh for SO_2 is based on the U. S. Environmental Protection Agency's estimate.	The Commission is waiting for the development of other reliable quantitative values for the other constituents addressed in the Clean Air Act Amendments.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Oklahoma	Awareness	Oklahoma does not require consideration.	Oklahoma is at an early stage in developing an Integrated Resource Plan.	There is a Notice of Inquiry calling for comments on the shape of an Integrated Resource Planning (IRP) rule, and there was a technical conference in the Fall of 1994.
Oregon	Operational	Oregon has an Order that requires utilities to perform sensitivity analyses using the following range of values — NO_x: \$2,000 - \$5,000/ton TSP: \$2,000 - \$4,000/ton CO_2: \$10 - \$40/ton. Utilities may also present the results of other approaches. If a utility chooses to rely on another approach to incorporate external effects, then it must explain why the approach is superior to the use of adders in the ranges listed above.	The Commission developed the ranges of values based on information presented by the various parties involved.	No change is anticipated.
Pennsylvania	Awareness	Pennsylvania does not require consideration of externalities.		The Commission may require Integrated Resource Plans (IRPs) to include externalities in the future.
Rhode Island	None	The Rhode Island Commission has not formally considered incorporation of externalities in evaluating new resources, and has not accepted externalities values on either the demand or supply side.	Commission staff participated in a regional study aimed at coordinating environmental externality policies in New England, but no regional consensus was reached.	The regional task force is continuing, with a focus now on coordinating among the States in such areas as Clean Air Act compliance.
South Carolina	Awareness	South Carolina does not require formal consideration. The utilities are voluntarily considering them qualitatively.		The Commission does not presently require consideration but is monitoring developments regarding the externality issue.
South Dakota	Awareness	South Dakota does not require consideration.	The Commission is focusing on other priorities relating to the Energy Policy Act of 1992, and has not considered the whole IRP process yet.	The Commission will decide on the Integrated Resource Planning (IRP) process and then decide on the externality issue.
Tennessee	None	Tennessee does not regulate electric utilities.		
Texas	Operational	Texas Rule states that in its Notice of Intent which sets forth its resource planning, a utility must consider external costs and benefits. While the rule does not explicitly stipulate quantification, utilities have generally quantified to the extent that they can. Recently, a judge ruled that qualitative treatment is insufficient.	Following the general guidelines of a 1983 statute on public utility regulation, the Commission believes it needs to consider environmental integrity when licensing plants.	IRP rulemaking is ongoing. If this IRP rule goes into effect, then the existing rule will be subsumed under the IRP rule. The proposed rule includes explicit consideration of at least the six most commonly considered air emissions.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Utah	Operational	Utah's Public Service Commission has promulgated IRP standards and guidelines that require consideration of externalities. Air emissions for each resource considered in the IRP must be quantified in terms of pounds, tons, etc. The standards require a risk mitigation analysis, based on a range of monetary values for the emissions, and mitigation strategies in the utilities' 2-year action plans.	"Prudent business planning must evaluate environmental risks and uncertainties."	No change is anticipated at this time.
Vermont	Operational	When computing avoided cost, Vermont requires 5-percent adders to reflect external costs in (all conventional) supply-side resources. For demand-side resources, costs are decreased by 10 percent to reflect the comparative risk benefit of demand-side management (DSM) measures relative to supply side.	An Order calls on the use of adders to reflect the external costs of producing and delivering electricity to end-users.	The Public Service Board is in the midst of a litigated proceeding which is considering different environmental costs among all resource options (supply, demand, and transmission and distribution).
Virginia	Awareness	While Virginia has used a 15-percent adder in the past, in a recent demand-side management review, the Commission rejected quantification.	The Commission considers that it has an obligation to consider environmental impacts, but that further study is needed before a policy on quantifying externalities can be developed.	The Commission feels that it should get direction on the issue from the General Assembly or Congress before adopting a comprehensive policy toward externalities.
Washington	Operational	Washington requires consideration of externalities in requests for proposals. A specific cost adder has been adopted. The Commission gives a 10-percent credit for conservation programs compared to supply options.	The 10-percent credit is based on Northwest Power Planning Council guidelines.	No change is anticipated.
West Virginia	None	West Virginia does not require consideration.	In regulating utilities, the Commission must balance the economic and other interests of the State.	No requirement for consideration is anticipated in the future.

Table A1. Summary of State Public Utility Commission's Activities Regarding Externalities (Continued)

State	Status	Approach to Incorporating Externalities	Rationale	Where is it going?
Wisconsin	Operational	Wisconsin requires quantitative and qualitative consideration. No specific methodology has been given; that is left to the individual utilities. Utilities must also reflect the risk that "greenhouse gases" will be regulated in the future using the numbers developed by the Commission. They are as follows: $15 per ton of CO_2; $150 per ton of CH_4 (methane); and $2,700 per ton of N_2O. The Commission also accepts the use of offsets.	The Commission does not feel that the Legislature intended to prohibit the Commission from accounting for externalities.	
Wyoming	None	Wyoming requires that utilities take all demonstrated costs into account in their IRPs. Wyoming does not require explicit consideration of externalities as these have not been demonstrated for the State of Wyoming.	Wyoming considers that it already has very stringent environmental laws that internalize all externalities of any significance or consequence.	No change is anticipated.

The "Status" categories that define each State's position on incorporating externalities in their regulatory requirements are defined as follows: •**Operational** means that the State has an order, rule, statute, or other legal decision that *requires* utilities to explicitly consider externalities in terms of monetary values, percentage adders, or on a qualitative basis; or to explicitly assess the risks of more stringent environmental regulation in the future (i.e., that externalities will have to be internalized in the future). •**Developing** means that the State is assessing the possibility of requiring utilities to consider externalities in their IRPs, or in some similar process. Thus, States in the midst of rulemaking, hearings, task forces, or other deliberations are in this category. •**Awareness** means that the State has no requirement for utilities to consider externalities and that it is not developing possible requirements, but that it has guidelines or that there is a reasonable possibility of considering requirements in the future. •**None** means that the State does not have a requirement (possibly having considered and rejected such a requirement), is not formally assessing the need for a requirement (or for an analysis of the risk of more stringent environmental regulations in the future), and is unlikely to take any of these actions in the foreseeable future. Based on this classification, the number of States in each category is O: 23 States; D: 5 States; A: 12 States; N: 11 States.

CO = carbon monoxide; CO_2 = carbon dioxide; CEC = California Energy Commission; CH_4 = methane; DSM = demand-side management; IRP = integrated resource planning/plan; NO_x = nitrogen oxide; N_2O = nitrous oxide; PM10 = particulate matter less than 10 microns in diameter; PUC = public utility commission; NSPS = new source performance standards; ROG = reactive organic gases; SO_2 = sulfur dioxide; SO_x = sulfur oxide; TSP = total suspended particulates; VOCs = volatile organic compounds.

Notes: This table was compiled by Russell Lee and Todd Stevenson of the Oak Ridge National Laboratory from discussions with State public utility commission (PUC) staff and review of PUC documents, supplemented with information from the Electric Power Research Institute's EPRINET database, Environmental Externalities News. The table was completed in early 1994. Subsequent changes are, therefore, not reflected in the above table. For example, the Massachusetts Supreme Judicial Court determined the designation of monetary values by the Massachusetts Department of Public Utilities to be beyond the range of its statutory authority. Accordingly, the electric utilities in Massachusetts are no longer required to incorporate externality values in their resource planning. **Avoided externalities**—social costs not incurred because the producer has taken some action to mitigate them. **Attainment**—in compliance with National Ambient Air Quality Standards or comparable State standards. **Avoided capacity costs**—quantification of avoided externalities due to increased technological efficiency or demand-side management, which has relieved the need to build additional capacity (thereby creating an increase in externalities). **Offsets**—programs designed to reduce the net increases in emissions by offsetting increases from one source by decreasing or by sequestering emissions from another source. **Adder**—a hypothetical cost added to electricity production costs, or subtracted from DSM programs, to represent an externality. The value of an adder is based on a percentage of the production cost.

Source: Oak Ridge National Laboratory, "The Impact of Environmental Externality Requirements on Renewable Energy" (Oak Ridge, TN, December 1994).

Glossary

Glossary

Note: Many of the environmental definitions contained in this glossary were excerpted with permission from the *Guide to Environmental Issues,* published by the U.S. Environmental Protection Agency.

Abatement: Reducing the degree or intensity of, or eliminating, pollution.

Acid Rain: Also called acid precipitation or acid deposition, acid rain is precipitation containing harmful amounts of nitric and sulfuric acids formed primarily by nitrogen oxides and sulfur oxides released into the atmosphere when fossil fuels are burned. It can be wet precipitation (rain, snow, or fog) or dry precipitation (absorbed gaseous and particulate matter, aerosol particles or dust). Acid rain has a pH below 5.6. Normal rain has a pH of about 5.6, which is slightly acidic. The term pH is a measure of acidity or alkalinity and ranges from 0 to 14. A pH measurement of 7 is regarded as neutral. Measurements below 7 indicate increased acidity, while those above indicate increased alkalinity.

Adders: Environmental adders are estimates of the monetary value of damage imposed upon society by each additional ton of a particular pollutant. In theory, when these values are added to the direct cost of resources under planning consideration, resources with the lowest *total social cost* can be identified.

Air Quality Standards: The level of selected pollutants set by law that may not be exceeded in outside air. Used to determine the amount of pollutants that may be emitted by industry.

Allowance: An authorization for the holder to emit a specified amount of a pollutant into the atmosphere as set forth in the Clean Air Act Amendments, i.e. one SO_2 allowance permits one ton of SO_2 emissions.

Alternative Fuels: Refers to requirements for replacing conventional fuels with alternative, less polluting fuels, established both by State governments and by the 1990 Clean Air Act Amendments.

Ambient Air: Any unconfined portion of the atmosphere; open air; outside surrounding air.

Avoided Costs: The incremental costs of energy and/or capacity, except for the purchase from a qualifying facility, that a utility would incur in the generation of the energy or its purchase from another source.

Beneficiation: The dressing or processing of ores for the purpose of (1) regulating the size of a desired product, (2) removing unwanted constituents, and (3) improving the quality, purity, or assay grade of a desired product.

Biodiversity: Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes.

Btu (British Thermal Unit): A standard unit for measuring the quantity of heat energy equal to the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit.

Chlorofluorocarbons (CFCs): A family of chemicals commonly used in air conditioners and refrigerators as coolants and also as solvents and aerosol propellants. CFCs drift into the upper atmosphere where their chlorine components destroy ozone. CFCs are thought to be a major cause of the ozone hole over Antarctica.

Climate Change: Potentially disruptive changes to the Earth's climate caused by rising absorption of the sun's heat. The sun's heat is captured within the Earth's atmosphere by so-called "greenhouse gases," such as water vapor, carbon dioxide, methane, and nitrous oxide. Atmospheric concentrations of these gases are rising due to human activities, including combustion of fossil fuels and deforestation.

Coal: A black or brownish-black solid combustible substance formed by the partial decomposition of vegetable matter without access to air.

Command and Control: The command and control approach attempts to control pollution by means of regulatory instruments. With the command and control approach, polluters are required to comply with certain regulations.

Conservation: Preserving and renewing natural resources to assure their highest economic or social benefit over the longest period of time. Clean rivers and lakes, wilderness areas, a diverse wildlife population, healthy soil, and clean air are natural resources worth conserving for future generations.

Cost-Benefit Analysis: As an economic tool for project evaluation or investment appraisal, cost-benefit analysis is used to quantify and compare the costs and benefits of alternative ways of achieving the same objectives.

Cost Effectiveness: This term refers to providing a given service or good with least cost.

Cradle-to-Grave or Manifest System: A procedure in which hazardous wastes are identified as they are produced and are followed through further treatment, transportation, and disposal by a series of permanent linkable, descriptive documents.

Criteria: Descriptive factors taken into account by EPA in setting standards for pollutants. For example, water quality criteria describe the concentration of pollutants that most fish can be exposed to for an hour without showing acute effects.

Damage Function Approach: A step-by-step approach to valuing environmental damages, starting from emissions, to concentrations, to impacts, to damage.

Damages: Following legal terminology, damages are the monetized value of detrimental impacts which accrue to society from the activities of producers and consumers. A related term, **benefit**, refers to the monetary value of positive impacts.

Demand: The functional relationship between the price and the quantity of a good demanded by the buyer.

Demand (Electric): The rate at which electric energy is delivered to or by a system, part of a system, or piece of equipment, at a given instant or averaged over any designated period of time.

Demand-Side Management (DSM): The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. It refers only to energy and load-shape modifying activities that are undertaken in response to utility-administered programs. It does not refer to energy and load-shape changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards. DSM covers the complete range of load-shape objectives, including strategic conservation and load management, as well as strategic load growth.

Dielectric Fluid: A fluid that can sustain an electric field. Because of its ability to permit the passage of the lines of force of an electrostatic field without conducting the current, it is used in transformers, capacitors, and between adjacent wires in a cable.

Discharge: The release of any waste into the environment from a point source. Usually refers to the release of a liquid waste into a body of water through an outlet such as a pipe, but also refers to air emissions.

Disposal: The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into the environment (land, surface water, ground water, and air).

Ecosystem: The interacting synergism of all living organisms in a particular environment; every plant, insect, aquatic animal, bird, or land species that forms a complex web of interdependency. An action taken at any level in the food chain, use of a pesticide for example, has a potential domino effect on every other occupant of that system.

Economic Efficiency: An optimum allocation of resources met when the price of a good equals its marginal cost. Externalities, public goods, monopoly, or decreasing cost production may undermine economic efficiency.

Effluent: Waste water, treated or untreated, that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Electric Power Industry: The privately, publicly, Federally, and cooperatively owned electric utilities of the United States taken as a whole. This includes all electric systems serving the public: regulated investor-owned electric utility companies; Federal power projects; State, municipal, and other government-owned systems, including electric public utility districts; electric cooperatives, including generation and transmission entities. Excluded from this definition are the special purpose electric facilities or systems that do not offer service to the public.

Electric Utility: A corporation, person, agency, authority, or other legal entity or instrumentality that owns and/or operates facilities within the U.S., its territories, or Puerto Rico for the generation, transmission, distribution, or sale of electric energy primarily for use by the public and files forms listed in the Code of Federal Regulations, Title 18, Part 141. Facilities that qualify as cogenerators or small power producers under the Public Utility Regulatory Policies Act (PURPA) are not considered electric utilities.

Emission: The release or discharge of a substance into the environment; generally refers to the release of gases or particulates into the air.

Emissions Trading: With an emissions trading system, a regulatory agency specifies an overall level of pollution that will be tolerated—a cap—and then uses allowances to develop a market to allocate the pollution among sources of pollution under that cap. Emissions permits or allowances become the currency of the market, as pollution sources are free to buy, sell, or otherwise trade permits based on their own marginal costs of control and the price of the permits. In no case can the total emissions exceed the cap.

Environment: The sum of all external conditions affecting the life, development, and survival of an organism.

Environmental Assessment (EA): A preliminary, written, environmental analysis required by the National Environmental Policy Act to determine whether a Federal activity, such as building airports or highways, would significantly affect the environment.

Environmental Impact Statement (EIS): A document prepared by or for the Environmental Protection Agency which identifies and analyzes, in detail, environmental impacts of a proposed action. As a tool for decision-making, the EIS describes positive and negative effects and lists alternatives for an undertaking, such as development of a wilderness area.

Factor Mobility: Factor mobility refers to the ease (or the lack of it) with which inputs or resources used in the process of production, i.e., land, labor, and capital, can be moved among competing uses.

Federal Power Facility: A utility that is either owned or financed by the Federal Government.

Flue Gas Desulfurization: The removal of sulfur oxides from the combustion gases of a boiler plant before discharge to the atmosphere. Chemicals, such as lime, are used as the scrubbing media.

Fossil Fuel: Any naturally occurring organic fuel, such as petroleum, coal, and natural gas.

Fuel Cycle: The series of physical and chemical processes and activities that are required to generate electricity from a specific fuel or resource.

Fuel Switching: A precombustion process whereby a low-sulfur coal is used in place of a higher sulfur coal in a power plant to reduce sulfur dioxide emissions.

Gas Turbine: A gas turbine consists typically of an axial-flow air compressor and one or more combustion chambers, where liquid or gaseous fuel is burned and the hot gases are passed to the turbine and where the hot gases expand to drive the generator and are then used to run the compressor.

Generating Unit: Any combination of physically connected generator(s), reactor(s), boiler(s), combustion turbine(s), or other prime mover(s) operated together to produce electric power.

Generation: The process of producing electric energy by transforming other forms of energy; also, the amount of electric energy produced, expressed in watthours (Wh).

Gigawatt: One billion watts.

Global Warming: The scientific hypothesis which states that the earth's temperature is rising as a result of the increasing concentration of certain gases, known as greenhouse gases, in the atmosphere, trapping heat that would otherwise radiate into space.

Greenhouse Effect: A popular term used to describe the roles of water vapor, carbon dioxide, and other trace gases in keeping the Earth's surface warmer than it would be otherwise. These radiatively active gases are relatively transparent to incoming shortwave radiation, but are relatively opaque to outgoing longwave radiation. The latter radiation, which would otherwise escape to space, is trapped by these gases within the lower levels of the atmosphere. The subsequent reradiation of some of the energy back to the Earth maintains surface temperatures higher than they would be if the gases were absent. There is concern that increasing concentrations of greenhouse gases, including carbon dioxide, methane, and manmade chlorofluorocarbons, may enhance the greenhouse effect and cause global warming.

Greenhouse gases: Those gases, such as water vapor, carbon dioxide, tropospheric ozone, nitrous oxide, and methane, that are transparent to solar radiation but opaque to longwave radiation. Their action is similar to that of glass in a greenhouse.

Gross National Product (GNP): The market value, in monetary terms, of goods and services produced by labor and property supplied by the residents of a nation, within a specified period of time.

Hazardous Substance: (1) Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive. (2) Any substance designated by EPA to be reported if a designated quantity of the substance is spilled in the waters of the United States or if otherwise released into the environment.

Hazardous Waste: By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Impact: This term is taken from the phrase, environmental impact statement, meaning the physical or socioeconomic effect of some activity. Examples of physical impacts are changes in crop yields, human health, and recreation resources. Examples of socioeconomic impacts are changes in aesthetics, noise nuisance, and employment conditions.

Integrated Resource Planning: In the case of an electric utility, a planning and selection process for new energy resources that evaluates the full range of alternatives, including new generating capacity, power purchases, energy conservation and efficiency, cogeneration and district heating and cooling applications, and renewable energy resources, in order to provide adequate and reliable service to its electrical customers at the lowest system cost. Often used interchangeably with *least-cost planning*.

Internalizing Externalities: This expression means to create social conditions where the damages (or benefits) from production and consumption are taken into account by those who produce these effects. These social conditions can be created by government regulation, a tort system, bargaining between private parties, or other policy and institutional arrangements. Benefits and damages can exist even when all externalities have been internalized.

Investor-Owned Utility (IOU): A class of utility that is investor owned and organized as a tax paying business, usually financed by the sales of securities in the capital market.

Kilowatt: One thousand watts.

Kilowatthour: One thousand watthours.

Least-Cost Planning: See *Integrated Resource Planning*.

Load Management: Efforts to change electricity demand to reduce cost; includes actions by consumers, utilities, or public agencies to reduce, shift, or increase demand at selected times.

Manifest System: Tracking of hazardous waste from "cradle to grave" (generation through disposal), with accompanying documents known as "manifests." See *Cradle-to-Grave*.

Marginal: Pertaining to the last unit, i.e., the marginal cost of an output is the increase in the total production cost of the output caused by producing the last unit of the output.

Marginal Benefit: The cost of damage avoided by reducing one additional unit of pollutant.

Marginal Cost: The cost of reducing one additional unit of pollutant.

Market Pricing Approach: The market approach to internalizing externalities attempts to put price tags on externalities directly in the marketplace, therefore causing the prices for products or services to reflect their full social costs. Market approaches that are discussed in the report include emissions trading, taxes, fees, liability, and subsidies.

Maximum Social Welfare: An allocation of resources that cannot be improved; that is, no one can be made better off without someone being made worse off. It can only be determined with the distribution of income taken as given.

Megawatt (MW): One million watts.

Megawatthour (MWh): One million watthours.

National Ambient Air Quality Standards (NAAQS): Maximum air pollutant standards that EPA set under the Clean Air Act for attainment by each State. The standards were to be achieved by 1975, along with State implementation plans to control industrial sources in each State.

Natural Gas: A naturally occurring mixture of hydrocarbon and nonhydrocarbon gases found in porous geological formations beneath the earth's surface, often in association with petroleum. The principal constituent is methane.

Non-Attainment: Refers to areas of the United States that have not met air standards for human health by deadlines set in the Clean Air Act.

Nuclear Reactor: An apparatus in which the nuclear fission chain can be initiated, maintained, and controlled so that energy is released at a specific rate. The reactor includes fissionable material (fuel), such as uranium or plutonium; fertile material; moderating material (unless it is a fast reactor); a heavy-walled pressure vessel; shielding to protect personnel; provision for heat removal; and control elements and instrumentation.

Operating Capability: The available capability of a generating unit excluding any limitations such as environmental, legal, or regulatory restrictions, extensive modifications or repairs, or being in a mothballed state.

Oxidant: A substance containing oxygen that reacts chemically with other materials to produce new substances. Oxidants are the primary ingredients in smog.

Ozone: Three molecule oxygen compound (O_3) found in two layers of the earth's atmosphere. One layer of beneficial ozone occurs at 7 to 18 miles above the surface and shields the earth from ultraviolet light. Several holes in this protective layer have been documented by scientists. Ozone also concentrates at the surface as a result of reactions between by-products of fossil-fuel combustion and sunlight, having harmful health effects.

Ozone Depletion: The depletion of the earth's stratospheric ozone layer, which protects life on earth from radiation. The use of synthetic chlorofluorocarbons (CFCs) is the principal cause of ozone depletion.

Particulates: Solid particles, such as ash, released in exhaust gases at fossil-fuel plants during the combustion process.

Perfect Competition: The condition where the actions of any single buyer or seller have no effect on the price of a product in the market. It requires a large number of buyers and sellers.

Permit: A legal document issued by State and/or Federal authorities containing a detailed description of the proposed activity and operating procedures as well as appropriate requirements and regulations. The permitting process includes provisions for public comment.

Petroleum: A mixture of hydrocarbons existing in the liquid state found in natural underground reservoirs, often associated with gas. Petroleum includes fuel oil No. 2, No. 4, No. 5, and No. 6; topped crude; kerosene; and jet fuel.

Petroleum (Crude Oil): A naturally occurring, oily, flammable liquid composed principally of hydrocarbons. Crude oil is occasionally found in springs or pools but usually is drilled from wells beneath the earth's surface.

Pollution: Any substances in water, soil, or air that degrade the natural quality of the environment, offend the senses of sight, taste, and smell, and cause a health hazard. The usefulness of the natural resource is usually impaired by the presence of pollutants and contaminants.

Polychlorinated Biphenyls (PCBs): A group of toxic, persistent chemicals used in electrical transformers and capacitors for insulating purposes, and in gas pipeline systems as a lubricant. The sale and new use of PCBs were banned by law in 1979.

Private Costs: Costs that are reflected in the market price and borne by the producers or consumers of a product or service.

Production Function: A mathematical relationship between the output of a firm (or the economy) and the inputs used to produce that output. The relationship can be so written that constant, increasing, or decreasing returns to scale can be exhibited.

Public Utility: An enterprise providing essential public services, such as electric, gas, telephone, water and sewer, under legally established monopoly conditions.

Qualifying Facility (QF): A cogeneration or small power production facility that meets certain ownership, operating, and efficiency criteria established by the Federal Energy Regulatory Commission (FERC) pursuant to the Public Utility Regulatory Policies Act.

Rate of Return: The ratio of net operating income earned by a utility calculated as a percentage of its rate base.

Release: Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous or toxic chemical, or extremely hazardous substance.

Renewables: An energy source that is regenerative or virtually inexhaustible. Typical examples are wind, geothermal, and water power.

Residual Emissions: Emissions containing pollutants which remain after compliance with all existing regulations.

Siting: Choosing a location for a facility.

Smog: Air pollution associated with oxidants.

Social or Societal Cost: The term social cost is often used interchangeably with the cost of externalities, but actually refers to the sum of private costs and the costs of externalities.

Solid Waste: Any solid, semi-solid, liquid, or contained gaseous materials discarded from industrial, commercial, mining, or agricultural operations, and from community activities. Solid waste includes garbage, construction debris, commercial refuse, sludge from water supply or waste treatment plants or air pollution control facilities, and other discarded materials.

Spent Nuclear Fuel: Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

Steam-Electric Plant: A plant in which the prime mover is a steam turbine. The steam used to drive the turbine is produced in a boiler where fossil fuels are burned.

Stranded Assets/Costs/Investment: Investment with a cost recovery schedule that was initially approved by regulatory action that subsequent regulatory action has rendered not practically recoverable.

Subsidies: Financial incentives that are employed to ensure the fulfillment of an environmental policy objective. Subsidies considered in this report are government financial support for capital investment in pollution control equipment or less polluting processes. Indirect subsidies, such as financial support for research and development related to pollution control, are not discussed in this report.

Technology Standards: Technology standards for pollution control can take various forms. These may include prescriptive technology requirements for certain pollution control measures; the prescription that best available technologies for pollution control have to be used; or specification of a minimum energy efficiency standard for residential appliances, industrial equipment, plants, buildings, or automobiles. Technology standards are often set on the basis of what can be done with available technology. The government specifies the equipment that must be used to control pollution. The only pollution permitted is that remaining after sources have installed the prescribed pollution control equipment.

Toxic Substance: A chemical or mixture that can cause illness, death, disease, or birth defects. The quantities and exposures necessary to cause these effects can vary widely. Many toxic substances are pollutants and contaminants in the environment.

Transboundary Effects: Transboundary effects occur when a source of pollution is within a separate government jurisdictional boundary from the one in which the impact of the pollution is incurred (for example, when winds carry SO_2 emissions from U.S. factories into Canada where the pollution is deposited as acid rain). Since the benefits of controlling transboundary pollution occur outside the government jurisdictional boundary, there is little incentive for the government jurisdiction to regulate transboundary pollution.

Utility: Investor-owned companies and public agencies engaged in the generation, transmission, or distribution of electric power for public use. Public agencies include municipal electric utilities, Federal power projects, rural electrification, cooperatives, power districts, and State power authorities and projects.