INCORPORATING ENVIRONMENTAL EXTERNALITIES IN AN INTEGRATED RESOURCE PLANNING PROCESS: ONE UTILITY'S EXPERIENCE

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In response to increasing regulatory attention nationwide, New England Electric undertook an effort to reflect environmental externalities in its integrated least-cost planning process. In conjunction with Temple, Barker, and Sloane, Inc., the Company developed a rating and weighting approach that allows all new supply and demand-side resources under consideration for the long range plan to be evaluated based on the range and severity of their environmental impacts. The rating and weighting approach provides an environmental externality "score" for each resource which has been used in the Company's planning process to determine a "adder" which, when applied to the total costs of a resource, provides a rough proxy of the resource's external environmental costs.

This paper describes the history of the development of the rating and weighting approach, the advantages and disadvantages of other methods, and the effect of including environmental externalities on New England Electric's long range resource plan. Although not perfect, the rating and weighting method has provided a useful mechanism for allowing the Company to recognize that different resources have dissimilar environmental effects and to reflect this fact in its resource planning process.

INTRODUCTION

In the late 1970s and through the 1980s, many electric utilities and utility commissions throughout the United States began adopting least-cost, integrated resource planning strategies. These strategies encouraged utilities to begin considering all resource options including demand-side options in addition to traditional supply-side options in their resource plans. The goal of this shift away from strict supply-side planning was to select resources that would result in the lowest cost of electricity services for consumers. Behind the momentum of this shift was the fact that many demand-side programs were significantly less expensive, on a kilowatt-hour and kilowatt basis, than many supply-side options. Consequently, demand-side options offered utilities a potentially enormous resource for meeting future demand.

An outgrowth of this gradual adoption of various forms of least-cost planning principles was a focus on a societal perspective in utility planning that considers what is best for society as a whole, as opposed to what is best for the utility and its customers. In other words, this perspective strives to lead utilities to develop a resource mix that is based on the lowest costs for society, not just for the utility. The California Energy Commission was the first regulatory agency in the country to issue guidelines for the development of a societal test for selecting resource options (California Standard Practice Manual 1987). Since these guidelines were issued in 1987, a number of utility commissions have issued orders establishing rules for resource planning that incorporate different components of a societal test.

One component of the societal test that has received increasing attention from a handful of utility commissions during the last three years are the costs of generating electricity that are external to the finances of the electric utility industry. Better known as external costs or externalities, these costs range from the costs of damage from the emissions of power plants to the effect on local property values from new generating facilities. While state and federal regulations require utilities to internalize some of these costs through, for example, emission controls such as electrostatic precipitators, regulations do not lead to total internalization. The objective of state utility commissions, when promulgating orders that require some level of internalization of external costs, is to guide utilities in selecting resource options that minimize these costs.

This paper provides an overview of how New England Electric[1], a medium-sized electric utility in New England, has incorporated external costs, principally environmental externalities, in its integrated resource planning process. It describes the development of a methodology for evaluating externalities, the application of this methodology to all resource options under consideration for the Company's resource plan, and the impact of this application on resource selection.

BACKGROUND

In November 1988, the Massachusetts Department of Public Utilities issued an order (Docket No. 86-36F) that required electric utilities to consider externalities in their analysis of resource options to meet future demand. Specifically, the order stated that the "evaluations of the cost-effectiveness of conservation and load management programs and other resource options should include, to the fullest extent practical and quantifiable, costs and benefits external to the transaction, most notably environmental externalities." The department recognized the difficulty of identifying and quantifying externalities, but expected the electric utilities to work with "other interested persons to develop suitable measurement methodologies over time" (DPU 86-36-F, p. 22).

In response to this order, New England Electric, on behalf of its retail subsidiary, Massachusetts Electric, considered different methodologies for evaluating environmental externalities for the purpose of incorporating them in its long range resource plan. In reviewing different methodologies, the Company evaluated a wide spectrum of options ranging from qualitative approaches, essentially lists, to quantitative approaches, such as complete monetization. The Company was specifically interested in a method that met the following objectives:

- consistency with the current state of the art in knowledge about externalities, both in level of detail and degree of precision;
- ease of applicability to New England Electric's integrated resource planning process;
- objectivity in its application to all supply and demand-side resource options considered by the Company; and,
- flexibility in its ability to be refined or replaced as the Company's experience with externalities broadens, as the current knowledge about environmental externalities improves, and as the Company's resource planning process further evolves.

The three primary categories of methods reviewed by New England Electric are discussed below.

Qualitative Approaches

The benefits of qualitative approaches are flexibility and adaptability. In a truly qualitative approach, resource options or portfolios of options are described in terms of their environmental attributes, such as emissions types and rates, water and land use and solid waste production. Decision-makers review the list of environmental attributes and other decision criteria (e.g., prices and risk) and develop a strategy for ranking resource options based on the qualitative assessment of their externalities. Since

[1] *The term "New England Electric" is used loosely to encompass three retail electric companies (Massachusetts Electric, Narragansett Electric, and Granite State Electric), New England Power Company, and their affiliates.*

any tradeoffs among attributes and criteria of different resources are implicit to the decision-maker, the disadvantage of this approach is its subjectivity.

Quantitative Approaches

Shifting away from the subjectivity of the qualitative approach and moving to the realm of absolute objectivity is the goal of the quantitative approach. In this approach, an attempt is made to completely monetize environmental externalities. Two paths are commonly used for this monetization: cost of damage and cost of control. Cost of damage attempts to quantify and monetize the impacts of externalities associated with different resource options. Cost of control attempts to use the costs of controlling pollution as a proxy for the actual damages that may result. While further discussion of these paths is beyond the scope of this paper, a number of studies on externalities have documented their advantages and limitations (Bernow, Marron 1990; Hohmeyer 1988; ECO Northwest 1984; Krupnick 1989; Chernick, Caverhill 1989, 1990).

The benefits of the quantitative approach, if it could be successfully implemented, are its objectivity and the ease of comparing the monetized cost of externalities to options' direct costs. The disadvantage of this approach is that all necessary data are not available. A review of current literature on cost of damage and cost of control, and discussions with acknowledged experts in the field, suggest that there are still insufficient data to enable monetization to be applied at a level of accuracy appropriate for utility resource planning (NEES 1989).

Hybrid Approaches

The alternative to the above approaches is the use of "hybrid" approaches that attempt to capture the objectivity of the quantitative and the pragmatism of the qualitative approaches. The primary advantage of these approaches is that they may be easily refined as improved data on externalities becomes available. Among the hybrid approaches, rating and weighting schemes have received considerable attention. Specifically, beginning with Orange and Rockland (O&R), all New York electric utilities have developed rating and weighting approaches for including environmental externalities in their all-resource bidding schemes (NYSPSC 1988, 1989). Other states, including California and Connecticut, are currently considering similar methods.

THE NEW ENGLAND ELECTRIC METHODOLOGY

After reviewing the different approaches to incorporating environmental externalities in its least-cost planning process, the Company chose to pursue the development of a hybrid approach. This decision was based on the fact that the approach would best meet the goals stated above and would allow immediate incorporation of environmental externalities in the Company's resource plan, NEESPLAN 1990, that was under development. The Company recognized that this approach would be geared toward providing usable results in the short run but would be followed by increasing levels of quantitative sophistication as additional data on actual social damages became available.

As the basis for a hybrid approach, the Company selected the framework of the O&R rating and weighting scheme and made a number of changes to it. The most important changes were: to focus on issues; to use several approaches to designing the rating and weighting scheme[2]; and to experiment with the use of expert polling to arrive at weights for individual issues.

Issue Focus: In deciding how to describe individual externality areas, work conducted by EPA, and presented in a series of reports entitled "Unfinished Business", was persuasive in the selection of an issue-oriented approach (USEPA 1987). In these reports, EPA staff ranked numerous environmental problems posing four major types of health and environmental risks. In order to compare very different types of risks, the EPA study group elected not to define environmental problems by sources, pollutants, pathways, or receptors. Instead, the group chose to "define the problems on the general

2 *In the New York Public Service Commission comments on O&R, a 1.405 cents/kWh externality adder is derived, relying principally on a cost of control methodology.*

basis of how the laws are written and environmental programs are organized. Since the goal of the project was to put together a useful tool to compare the risks with which EPA was concerned, the project team decided to draw up a list of environmental problems that reflect how people think of the problems" (EPA 1987).

Approaches to Designing a Rating and Weighting Scheme: Rather than adopt a single approach to selecting ratings and weightings, a more holistic approach was chosen. For example, instead of using purely negotiation or purely damage costs[3], it was recognized that a number of elements could contribute to the determination of an issue's rating and weighting structure. For example, where relative toxicities are available, this data may be used to help establish the trade-off value of two pollutants. For other externalities like land use, relative toxicity is meaningless and so other approaches must be used. Several of the approaches considered in this methodology are discussed in the next section of the paper.

Expert Polling: As part of the methodology development process, an experiment was conducted to assess whether it is feasible to poll experts as a way to assign weights to environmental externalities. As far as the Company was aware, this technique had not yet been applied to the task of designing externality evaluation methodologies. Briefly, the polling instrument asked participants to assign relative weights (by dividing 100 points) to a list of environmental attributes. The approach is described in more detail in a report available from New England Electric (NEES 1989).

Overview of Matrix

The end product of the Company's work on developing its externalities methodology is shown in Figure 1. This matrix is relatively simple, providing the means for rating and weighting each option on a single page (NEES 1990).

3 *While using damage costs is the ideal approach, it is currently not possible because damage costs estimates are not available for many externalities.*

The left hand column, Column B, of the matrix lists the ten externality issues for which each option is evaluated. Each issue receives a weight (Column A) reflecting the relative significance of its environmental impacts. Column D lists the contributing factors (environmental agents or subissues) for each issue. Weights for the contributing factors, shown in Column C, reflect the relative importance of each factor within the issue to which it is assigned. Columns E through I provide the ratings from zero to four for each contributing factor. After the contributing factors are weighted for each resource option, weights are applied to the ratings giving a weighted impact score (Column J). For some of the environmental issues, several "contributing factors" are separately rated, weighted and then summed to form the issue score. These scores are then added to yield a composite score for each resource option (Column K). A brief description of the process by which issues, factors, weights, and rates were determined is provided below.

Selection of Issues

The first step in developing the matrix was the compilation of a list of major environmental externalities for which each demand and supply-side resource option would be evaluated. The externalities were then grouped into issues (Figure 1, Column B), such as global warming and acid rain, to allow them to be described in a fashion similar to the way the public thinks about them. For example, while the public may not have an opinion on the importance of mitigating sulfur dioxide or carbon dioxide, they may have opinions on the importance of acid rain or global warming.

Weighting of Issues

The issue weights in the matrix were determined through a blend of two different types of information, including polling of experts and weights assigned in previously developed rating and weighting schemes. In addition, a number of studies and reports on individual issues and combinations of issues contributed to the determination of the final weights used in the matrix (NEES 1989). While a strictly quantitative approach to defining weights

A	B	C	D	E	F	G	H	I	J	K
ENVIRONMENTAL CONCERN		CONTRIBUTING FACTOR		LEAST ------------> IMPACT ------------> MOST					Impact	Issue Score
Weight	Issue	Weight	Factor	0	1	2	3	4		
9%	Global Warming	100%	Carbon Dioxide (lb/kWh)	0	0.63	1.25	1.88	2.5		
14%	Acid Rain	50%	Sulphur Dioxide (lb/mmbtu)	0	0.3	0.6	0.9	1.2		
		50%	Nitrogen Oxides (lb/mmbtu)	0	0.15	0.3	0.45	0.6		
7%	Land Use	*	Amount (acres)	0	2000	4000	*multiply "amount" score by "character" score to calculate impact			
			Character	industrial	res/com/farm	pristine				
14%	Solid Waste	100%	Overall Assessment (lbs/kWh)	0	0.05	0.1	.015	0.2		
			Adjustment							
16%	Water Use/Quality	20%	Amount (gallons/MWh)	0	150	300	450	600		
		40%	Attributes of Input Water	no water used	minor loss of recreational area	minor loss of habitat	major loss of recreational area	major loss of habitat		
		30%	Thermal Attributes of Receiving Water	no change		receiving water with minor thermal change		receiving water with major thermal change		
		10%	Chemical Attributes of Receiving Water	no change		receiving water with minor chemical change		recieving water with major chemical change		
16%	Emissions to Air	25%	Air Toxics (fuel type)	no fuel		natural gas		coal or oil		
		25%	Particulates (lb/mmbtu)	0	0.0075	0.015	0.0225	0.03		
		25%	Sulphur Dioxide (lb/mmbtu)	0	0.3	0.6	0.9	1.2		
		25%	Nitrogen Oxides (lb/mmbtu)	0	0.15	0.3	0.45	0.6		
2%	Aesthetics	40%	Visual Effects	not visible or obtrusive	seasonally visible	visible from major roads	visible from recreation areas	visible from sensitive areas		
		40%	Noise	no noise	below nighttime ambient	below daytime above nighttime	above daytime ambient	meets property line limit		
		20%	Signal Interference (households affected)	0	10	20	30	40		
2%	Indoor Air Quality	10%	Creation	reduces production		no effect		increases production		
		90%	Retention (air changes)	increases number		no effect		reduces number		
4%	Fuel Issues	100%	Overall Assessment	no fuel		natural gas		coal/oil		
16%	Ozone	45%	VOCs (lb/mmbtu)	0	0.0015	0.003	0.0045	0.006		
		45%	Nitrogen Oxides (lb/mmbtu)	0	0.15	0.3	0.45	0.6		
		10%	CFCs	no release				CFCs released		

Figure 1. Environmental Externalities Matrix

would have been preferred, the current lack of reliable quantitative studies does not allow for complete quantification.

Selection of Contributing Factors

Contributing factors are the individual components of issues. Some issues have only a single contributing factor while others have several. These factors are selected on the basis of their contribution to the issues. For example, sulfur dioxide and nitrogen oxides are the contributing factors that are used to assess a resource option's effects on acid rain. These two factors have been chosen from the list of acidic precursors from man-made and natural resources because they are most closely linked to utility sources. Figure 1 shows the contributing factors for each issue.

In some cases, proxies for the true environmental agents have been chosen as contributing factors. For example, under the Emissions to Air issue, fuel type is used as a proxy for air toxics. Rather than listing the many specific air toxics that can be emitted in minute quantities, the framework takes advantage of their correlation to fuel type (U.S. DOE 1989).

Rating of Contributing Factors

In rating contributing factors, a sensible measurement scale for differentiating between resources must be determined. The range of the scale should accommodate most potential resource options so the upper limit may often be set by the greatest effect that would reasonably be proposed in a qualifying facility bid (e.g., NSPS limits for air emissions for a pulverized coal station). The lower limit may be set at zero effect, or lower where positive effects are achievable. The approaches used for rating factors are discussed below.

Regulatory: Regulatory ratings and weights are derived from existing or potential legislation. Assuming legislation reflects society's values, issues and contributing factors can be compared at the margin on the basis of society's preferences.

Range of Options: This approach normalizes the ratings to cover the typical range of electric utility options. For example, the carbon dioxide upper bound could be set by the carbon dioxide output of a pulverized coal plant.

Root Cause: This approach merely simplifies individual resource option evaluations by reducing complicated after-effects to their root causes. For example, it is possible to reference part of the externalities analysis to indices based on fuel type.

Grading: The central notion of grading approaches is that there are several features of a resource which can lead to it earning a particular rating. It is a particularly useful concept for complex, site-specific externalities such as land use and water use/quality. The advantage of the approach is that it can accommodate a large number of dissimilar elements simultaneously.

State of the Art: This approach recognizes that the rating scheme should not attribute a great deal of precision to an issue that is either not well understood, or not well linked to utility options.

Reference to Other's Work: This approach takes advantage of prior thought on this topic by incorporating the rating approaches developed in other jurisdictions. For example, the rating design for aesthetics filed by O&R has been adopted in the New England Electric methodology.

Weighting of Contributing Factors

Weights for each contributing factor represent the factor's contribution to an issue. Within an issue, contributing factor weights must sum to 100%. As with factor rating, several approaches may contribute to the estimation of factor weights. These approaches are discussed below.

Multiplicative: This approach is useful in instances (e.g., land use and water use/quality) when contributing factors interact. For example, land use depends both on the nature of the land affected and the acreage.

Regulatory: As in the regulatory rating methodology, the regulatory weighting methodology relies on current or pending regulations to provide issue weights.

Expert Polling: The use of expert polling for some issues is supported by the current lack of specific data for evaluating tradeoffs between some agents. The approach is holistic, calling on the professional experience of the environmental policy expert and is consistent with the complex and diverse nature of the externalities subject area.

APPLICATION OF METHODOLOGY TO INTEGRATED RESOURCE PLAN

As part of the development of the Company's long range resource plan, NEESPLAN 1990, resource options from both New England and Canada were examined using the rating and weighting approach. Project-specific environmental scores can be found in Table 1. As one would expect, coal-fired resources received the highest environmental scores, thus indicating a higher level of potential environmental degradation. Conservation programs and distribution system upgrades received the lowest scores, reflecting little, if any, potential for environmental harm.

To include the environmental score for a resource in the determination of its cost-effectiveness, several options were considered. The first was to simply let the scores determine the ranking of resources within a particular range of cost-effectiveness. For instance, all projects with cost-benefit ratios of 0.7 to 0.8 could be selected in order of lowest to highest environmental score. In other words, an option with a cost-benefit ratio of 0.8 and with a low environmental score would be selected before an option with a 0.7 cost-benefit ratio and a higher environmental score. This option was not adopted because it may give the environmental scores very little weight in the resource selection process. It may also lead to inconsistent results. For example, using the example above, a project with a 0.69 cost-benefit ratio and a high environmental score would be chosen before a project with a 0.70 cost-benefit ratio and a very low environmental score. Clearly, this approach may defeat the purpose of including environmental externalities in the planning process by providing inconsistent and illogical results.

The second option examined a point scheme similar to that used in new resource bidding mechanisms. In other words, points would be assigned to all attributes (price, dispatchability, environmental score, etc.) and the resource selection would be made based on a resource's overall point score. This option, although potentially useful in a bidding framework, simply would not integrate well with the Company's planning process. The planning techniques and models used at the Company rely on actual cost estimates, and not scores, to determine appropriate resource selection.

The third, and chosen, option was to attempt to place a monetary value on the externality score and add that expense directly to the cost of the resource. By translating the scores into cost "adders", the integration with the planning process and planning models was straightforward. Resource planners and planning models are accustomed to tracking costs and by monetizing the scores, there was simply one additional cost to be considered.

Although monetizing the scores is a way to integrate the environmental externality scores into the planning process, obviously it is not an easy task to determine how the scores should be monetized. The chosen method assigned the project with the highest environmental score, and hence, the highest level of potential environmental degradation, a cost penalty of 15 percent. The present value of all direct costs associated with the project (capital, O&M, fuel, and other associated costs) was increased by 15 percent to reflect environmental externalities. Other projects received an adder that was based on the ratio of their score to the highest score. For instance, one option considered in the development of the Company's long range plan was a 20-year power purchase from a yet-to-be constructed coal-fired unit. This option, when examined using the Company's rating and weighting methodology, received the highest environmental score at 2.66 and, therefore, was assigned an adder of 15 percent. If another project received a score of 1.33, the present value of its direct costs were increased by 7.5% (calculated as 1.33/2.66 * 15%). Hence, the environmental cost adder received by a project was directly related both to its environmental score and its direct costs. If two projects received similar scores but one was more costly than the other, the project with higher costs would also receive a higher environmental cost penalty. A list of the externality percent adders are shown in Table 1.

Table 1. Environmental Externality Scores, Cost Adders, and Cost-Effectiveness Results

Demand-Side Options	Environmental Scores	% Cost Adder	Cost-Benefit Ratio Excl. Externalities	Cost-Benefit Ratio Incl. Externalities
Commercial and Industrial Programs	(0=no impact; 4=maximum impact)			
- Retrofit Conservation	0.04	0.2%	0.35	0.35
- Retrofit Load Management	0.07	0.4%	0.32	0.32
- New Construction Conservation	0.04	0.2%	0.25	0.25
- New Construction Load Management	0.07	0.4%	0.32	0.32
- Interruptible Rates	0.68	3.8%	0.57	0.59
- Standby Generation	1.68	9.5%	0.57	0.63
Residential Programs				
- Low Income	0.04	0.2%	0.69	0.70
- New Construction	0.09	0.5%	0.93	0.93
- Electric Space Heat Retrofit	0.08	0.5%	0.56	0.57
Supply-Side Options				
Power Purchase from an Unscrubbed Coal Unit	2.66	15.0%	0.83	1.01
Atmospheric Fluidized Bed Coal	2.57	14.5%	0.94	1.11
Natural Gas-Fired Combined Cycle	1.07	6.1%	0.75	0.79
15 MW #2 Oil-Fired Peaking Unit	1.44	8.1%	0.87	0.92
Purchase from a Biomass Unit	2.05	11.6%	0.78	0.89
Canadian Hydro	0.66	3.7%	1.04	1.09

Choice of Maximum 15 Percent Adder

As mentioned earlier, a direct-cost approach examining the costs of damage is the most preferable way to address the costs of environmental externalities. To do so, all externalities would be identified and the costs, or benefits, of each externality would be determined. However, the data at this time does not allow for such an approach. Although recognizing that much work has been undertaken by various parties to direct cost specific externalities, the tremendous variance one witnesses in the estimates does not provide confidence in the usefulness of the estimates at this time. For instance, a state study concluded that the value of fish loss in Lake Michigan due to acid rain was $6.2 million per year. Another evaluation indicated the loss was $50,000 per year, less than one percent of the state estimate. In addition to a large variation in estimates, much of the research at direct costing is area-specific and may not be directly transferable to another region.

A maximum 15 percent penalty was arbitrarily adopted, not analytically estimated. The Company chose a 15 percent penalty for several reasons. First, it is large enough to lead to changes in the resource plan. The 15 percent penalty improves conservation program cost-effectiveness and limits the cost-effectiveness of some supply-side options. At the same time, the 15 percent penalty is not so large that unforeseen problems with the methodology might significantly distort resource plans in the short term. Secondly, 15 percent is merely an initial estimate that can be revised as the Company gains more experience with environmental externalities, more research becomes available, and feedback from regulators, customers, and interested parties is received. Finally, 15 percent is within the range of adders adopted in other jurisdictions, including Wisconsin, Vermont, and New York (Wisconsin Public Service Commission 1989; Vermont Public Service Board 1988; Putta 1989).

Cost-Effectiveness Determination

The traditional approach to determine resource cost-effectiveness is to minimize the cumulative present value of direct costs to a utility's customers (i.e., the utility's revenue requirements). To include societal costs, such as environmental externalities, requires an expanded, or societal cost-effectiveness approach. In Order 86-36-F, the Massachusetts Department of Public Utilities specified a cost-effectiveness test that can be called a "modified total-resource cost test". Under this perspective, the costs of any resource include the utility's revenue requirements, environmental externalities, and the customer costs associated with demand-side programs. The benefits include the value of avoided capacity and energy costs, and any customer savings from demand-side programs, not including bill savings.

Effect on Resource Cost-Effectiveness and Long Range Plan

Using the modified total-resource cost test tended to improve demand-side and worsen supply-side cost-effectiveness. In particular, the cost-effectiveness of new coal-fired resources was jeopardized by the environmental cost penalty. Before the environmental penalty was applied to a purchase from a third-party coal-fired unit, the cost-benefit ratio for the resource was 0.83. After the penalty, the resource's cost-benefit climbed to 1.01, indicating that the resource was not cost-effective. The results for an atmospheric fluidized bed unit were similar; 0.94 before and 1.11 after. All other supply-side options retained their cost-effectiveness after the penalty was applied. Natural gas-fired units, in particular, remained cost-effective.

All demand-side programs examined during the planning process remained cost-effective and are included in the long range resource plan. At present, the resource plan shows one-third of the Company's incremental capacity needs being met by demand-side programs. Because the inclusion of environmental externalities tended to improve demand-side cost-effectiveness, there are now more cost-effective demand-side opportunities than previously. Previously marginal or slightly non-cost-effective opportunities when examined using a revenue-requirements-only perspective are now cost-effective when externalities are considered. Effort is ongoing to identify these resources so that future plans can reflect their improved attractiveness.

For the long range plan, a small amount of new coal-fired resources have been included even though their cost-effectiveness appears jeopardized by the consideration of environmental externalities. Less than ten percent of incremental needs are expected to be met by new coal-fired generation from third party suppliers and no new Company-owned coal-fired generation is planned.

One of the reasons new coal-fired generation has been kept in the resource plan even though it appears not to be cost-effective is for fuel diversity considerations. The Company's fuel mix is expected to become very dependent on natural gas-fired generation within the next ten years. Natural gas is expected to climb from essentially zero percent of the Company's fuel mix at present to 25 percent by 1999, and to 36 percent by 2009. If new coal-fired resources were excluded entirely from the long range plan, some of coal's contributions to meeting Company needs may have to be replaced with additional gas-fired resources. In this case, lack of fuel diversity could prove to be a serious threat. The problem with excluding all coal-fired generation from the resource plan is that the Company fuel price forecasts and estimates of fuel markets expect coal prices to be more stable than other fuels. Price stability and protection against rate volatility are worthy goals and at this time, excluding coal entirely from the resource plan may jeopardize this goal.

Another reason coal has been kept in the resource plan is that societal costs include more than just environmental externalities. There are other externalities, such as economic or social, that should also be considered. This is not to imply that these additional considerations will necessarily work to the advantage of coal-fired generation. It is merely to indicate that moving towards a societal perspective for resource selection raises many difficult issues that should be considered before entirely ruling out any resource.

LIMITATIONS AND PLANNED REVISIONS TO THE METHODOLOGY

In using the rating and weighting approach during the Company's planning process, limitations in both the methodology and in its application became apparent.[4] Some of the problems found with the rating and weighting approach include the need for the following: (1) unlimited bounds in all externality issue categories; (2) reexamination of the weightings given to all externalities; (3) the incorporation of additional externalities into the matrix and the possible removal of other externalities now included in the matrix; and (4) the inclusion of positive credits or offsets. These changes will be addressed prior to the completion of the next resource plan. In addition, the relationship of the methodology to the planning environment is also being reviewed.

The matrix will be revised to include no upper bound on the externalities score. The impact ratings that at present can not exceed a score of four will be removed. The reason for this change is that during the use of the matrix, it became obvious that some resources had effects that exceeded the bounds initially established for the matrix. Removing the upper bound on the score will allow for greater variances between projects to be considered. The weightings will also be examined to determine if they should be revised based on new information, scientific opinion, or public perception. In addition, the Company will determine if additional externalities should be considered (such as methane) and if certain externalities (such as indoor air quality) should be removed. Finally, it became quite clear that the approach should have the ability to recognize improvements to the environment brought about from any resource. For instance, a repowering project of an existing unit, even though it adds capacity, may lead to less total emissions to the environment. Similarly, a power project may add a waste treatment facility to a town, thereby improving the quality of waste water released to the environment. A matrix approach that examines only increases in externalities misses these important changes.

CONCLUSION

In developing this methodology, the Company has taken the first-step at incorporating environmental externalities in its resource planning process. Although the approach is not without its shortcomings, it does provide a mechanism for addressing a difficult and complex issue. By accounting for a broad range of environmental effects in a manner which is simple, explainable, and reasonable, given

[4] *Critical reviews have also been completed by PLC, Inc. (PLC 1989 and 1990: Memos to New England Power Service Co.) and the Massachusetts Division of Energy Resources/Tellus Institute (Shimshak 1990).*

present information, the approach provides a framework for discussion that various parties can understand and agree upon. While complete monetization of externalities may be the ultimate goal of addressing external costs, the hybrid approach described in this paper offers an effective short-term alternative. As public utility commissions, utilities, national laboratories, universities, and other organizations delve further into monetization, the resultant data can be used on an ongoing basis to refine the ability of this approach to accurately capture the true environmental costs of different resource options.

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REFERENCES

Bernow, S. S., and D. B. Marron. 1990. *Valuation of Environmental Externalities for Energy Planning and Operations*. Tellus Institute. Boston, Massachusetts.

Chernick, P., and E. Caverhill. 1990. *Report to the Boston Gas Company on Including Environmental Externalities in 89-239*. PLC, Inc. Boston, Massachusetts.

Chernick, P., and E. Caverhill. 1989. *The Valuation of Externalities from Energy Production, Delivery, and Use, Fall 1989 Update*. Report to the Boston Gas Company. PLC, Inc. Boston, Massachusetts.

Chernick, P., and E. Caverhill. Memos to New England Power Service Company on the New England Electric Externalities Methodology. (January 5, 1990, February 14, 1990)

Energy System Emissions and Material Requirements. 1989. Prepared for the Deputy Assistant Secretary for Renewable Energy. U.S. DOE, Washington, D.C.

Environmental Protection Agency. 1987. *Unfinished Business: A Comparative Assessment of Environmental Problems Overview Report*. Washington, D.C.

ECO Northwest, Shapiro and Associates, and Seton, Johnson, and Odell. 1984. *Economic Analysis of the Environmental Effects of a Combustion-Turbine Generating Station at Frederickson Industrial Park, Pierce County, Washington*, Final Report submitted to the Bonneville Power Administration under contract with United States Department of Energy, Portland, Oregon.

ECO Northwest, Shapiro and Associates, and Seton, Johnson, and Odell. 1986. *Estimating Environmental Costs and Benefits for Five Generating Resources*, Final Report and Technical Appendices submitted to the Bonneville Power Administration under contract with United States Department of Energy, Portland, Oregon.

Krupnick, A. 1989. *The Environmental Costs of Energy Supply: A Framework for Estimation*. Resources for the Future. Washington, D.C.

Massachusetts Department of Public Utilities. 1988. Docket No. 86-36-F. Boston, Massachusetts.

New England Electric System. 1989. *Integrating Environmental Externalities into Resource Planning at New England Electric*. Study prepared by Temple, Barker and Sloane. Lexington, Massachusetts.

New York State Public Service Commission. Cases 88-E-240 through 88-E-245. Albany, New York.

Putta, S. N. 1990. "Need and a Method for Valuing Environmental Costs in Deregulated Power Generation." Paper presented at the Eastern Regional Business and Economics Utilities Conference.

Putta, S. N. 1989. "Consideration of Environmental Externalities in New York State Utilities' Bidding Programs for Acquiring Future Electricity Capacity." New York Public Service Commission.

Shimshak, R., B. Biewald, H. Salgo, D. Marron, and S. Bernow. 1990. "Comments of the Division of Energy Resources on Environmental Externalities", presented before the Massachussetts Department of Public Utilities, Case No. DPU 86-36-G and DPU 89-239, March 2, 1990.

Standard Practice Manual: Economic Analysis of Demand-Side Management Programs. 1987. California Public Utilities Commission, California Energy Commission. Sacramento, California.

State of Vermont Public Service Board. 1988. *Investigation into Least Cost Investments, Energy Efficiency, Conservation and Load Management of Demand for Energy*. Hearing Officer's Report and Proposal for Decision. Docket No. 5270. Montpelier, Vermont.

State of Wisconsin Public Service Commission. 1989. *Advance Plan 5 Order*. Docket No. 05-EP 5. Madison, Wisconsin.