Integrated Planning and the Environment at New England Electric

Jonathan B. Lowell
New England Power Service Co.

Consideration of environmental impacts has become increasingly important in utility resource planning decisions today. The New England Electric System Companies have established a goal to reduce their weighted overall release of eight principal air emissions by 45% by the year 2000. This objective involves specific reduction targets for each of three significant components, SO_2, NOx, and CO_2. Our integrated resource plan outlines how demand-side programs, fuel conversions, renewable resources, and greenhouse gas offset programs will be used to achieve these goals, in a cost-effective manner designed to provide reliable service while holding rate increases at or below inflation over the next ten years. The plan goes beyond legal compliance to provide significant, cost-effective environmental improvement in the spirit and tradition of utility least cost planning. This paper describes the planning framework that will be used to achieve these goals, and argues that results oriented incentive based regulatory approaches are preferable to schemes dependent on externality "adders".

Introduction

To meet the needs of its customers and shareholders today, a utility must look beyond the direct cost of its product. Customer and regulator satisfaction requires not only the lowest possible cost for electric service, but continuous and significant improvements in environmental performance. In 1979 and 1985, the New England Electric System Companies (the Companies) announced NEESPLAN and NEESPLAN 2 respectively, which committed the Companies to conservation and load management as important resource options, and to the principles of integrated resource planning. Both are important ways to achieve low stable costs. In 1991, the Companies announced NEESPLAN 3: Environment, Economy, and Energy in the 1990s, a resource plan and planning framework that directly confronts the challenges of environmentally responsible planning in the 90s.

Regulatory Background

In 1990, the Massachusetts Department of Public Utilities (MDPU) and the Energy Facilities Siting Council (EFSC) issued major orders (MDPU Order 89-239 and EFSC Order RM-100-A) that established new resource planning requirements designed to emphasize competitive bidding and incorporate the environmental externalities of electricity production into the new resource selection process. Monetary values were established for eight air pollutants that were judged by the MDPU and EFSC to reflect the social cost of residual emissions. These values were estimates of the damage caused by the residual emissions and were derived using a "revealed preferences" methodology.[1] The merits of these particular values have been extensively debated elsewhere[2] and the Companies have proposed alternative values based upon a market based "marginal cost of control"[3,4] that we believe more closely represent the true social cost of these emissions (see Table 1).[5] This debate[6], while interesting and extensive, is not important to the conclusions of this paper; however, the concept of a quantitative basis for relating and comparing different air emissions is essential to developing a framework for measuring environmental performance and improvement.

An Emissions Index

Using these values and the total annual actual or projected emissions for a proposed resource plan, it is simple to construct a weighted emissions index to measure the relative environmental impact of the proposed resource plan. Using 1990 as a base year (the most recent year for which actual data were available), the value of the index for future year "y" would be:

$$Index_y = \frac{\sum_{i=1}^{8} (tons_{i,y} * value_i)}{\sum_{i=1}^{8} (tons_{i,1990} * value_i)}$$

Tons of emissions are projected for all resources operated for the benefit of our customers, whether or not they are owned by the Companies. In particular, emissions attributable to power purchased from other utilities and non-utility generators are included, and emissions from

Table 1.

Air Emission	Mass. DPU 1989 $/ton	Initial Company Proposed 1989 $/ton
Sulfur Dioxide (SO_2) - a contributor to acid rain	1500	600
Nitrogen Oxides (NOx) - contributors to ozone formation and acid rain	6500	200
Carbon Dioxide (CO_2) - a greenhouse gas	22	2
Particulates - dust and ash, which pose health risks	4000	300
Volatile Organic Compounds (VOCs) - contributors to ozone formation	5300	250
Carbon Monoxide (CO) - a respiratory irritant and a greenhouse gas	870	14
Methane (CH_4) - a greenhouse gas	220	20
Nitrous Oxide (N_2O) - a greenhouse gas	3960	360

Company-owned facilities whose output is purchased by other utilities are not included. In the jargon of the New England Power Pool (NEPOOL), this is referred to as "own-load" emissions from a simulated "own-load" production dispatch, the same basis used for allocating fuel costs to individual utilities within the NEPOOL integrated dispatch.

Different resource plans will provide different amounts and different mixes of emissions. The index weights each component and provides a single overall impact number that can be used to compare and choose among the alternative resource plans. When used in this manner, the absolute monetary value of the index is unimportant. It is used only for the purpose of determining which resource plan has lower environmental impacts, and for measuring improvement in environmental performance over time relative to the 1990 base period. Measuring environmental impact on a composite weighted basis leaves utilities with the flexibility to seek improvements in the most cost-effective manner. If a ton of methane could be avoided for the same cost as a ton CO_2, it would make sense to invest in methane emission reduction because it has a much higher "value" than CO_2 under either MDPU or the Companies' values.

Different sets of externality values will lead to different emission indices, but only the relative values of one type of emission to another are important. In general, the MDPU values are an order of magnitude higher than the Companies' values, but analysis indicated that, even with these widely different sets of values, the resulting emission indices were very similar. As a tool for measuring overall environmental improvement, the weighted emission index was relatively insensitive to the sets of externality values under discussion.

Figure 1 illustrates this point. Emission indices created using the externality values proposed by the Massachusetts Department of Public Utilities and values proposed by the Companies follow very similar patterns. The "Company Values" index upon which the NEESPLAN 3 goal is based applies relatively more weight to SO_2, and results in somewhat lower values. The highest of the three lines illustrates where the index would fall if no environmental improvements were implemented and 1990 emission rates continued forward into the future. Note that the indices in Figure 1 reflect only the Companies' direct "own-load" emissions and do not account for the impact of possible emission offsets that may be pursued. Potential offsets are discussed in greater detail in the Greenhouse Gas Offsets section.

Using either set of externality values, three emissions, CO_2, SO_2, and NOx dominate the indices, accounting for over 98% of the total value in 1990 in both cases (see Figure 2). It is clear that any environmental improvement

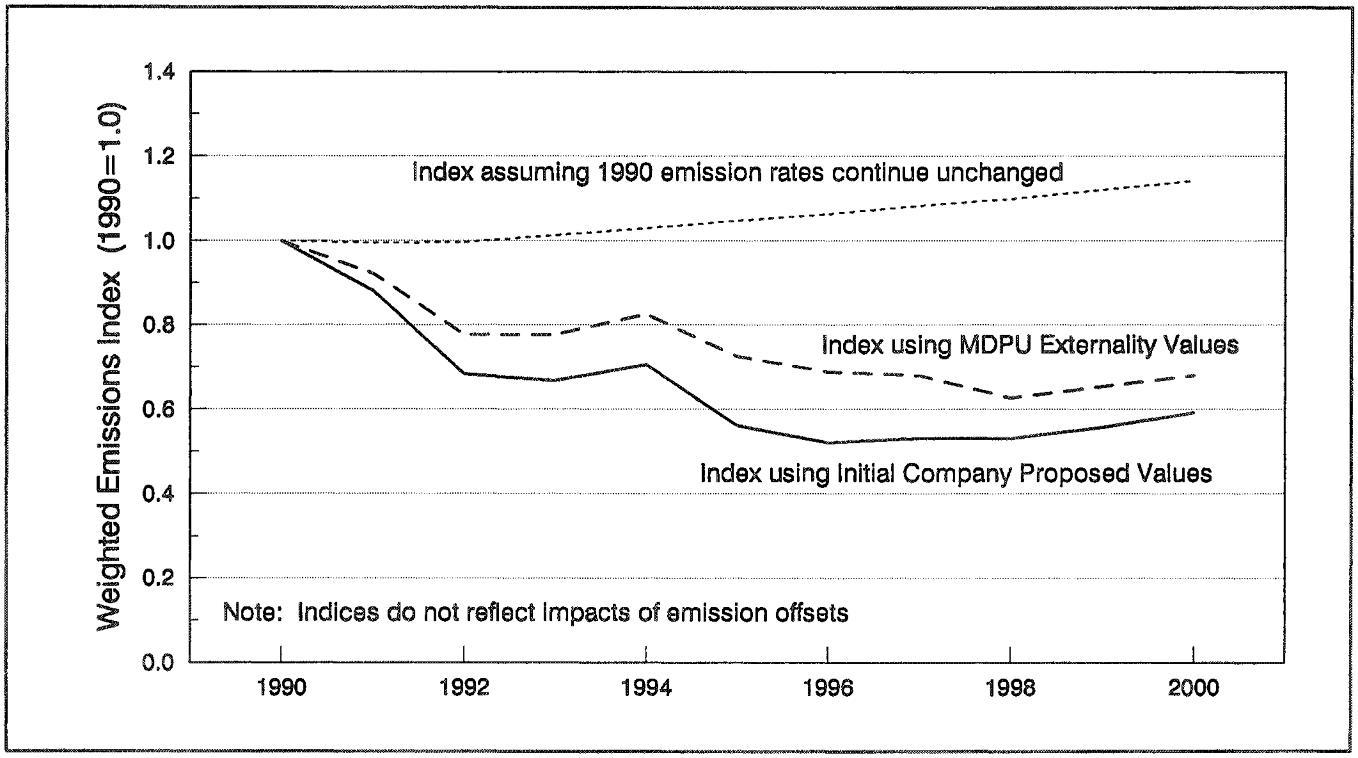

Figure 1. Weighted Emissions Index

strategy must attack these three emissions to have any significant impact.

The NEESPLAN 3 Goals

Customer surveys taken by the New England Electric System Companies consistently indicate that our customers want their utility to minimize environmental impacts. But they also consistently indicate that customers want improvement at low cost--they don't want to spend a lot of money. They also put a high value on adequate and reliable service. To meet these expectations in an increasingly competitive industry, NEESPLAN 3 incorporates three goals:

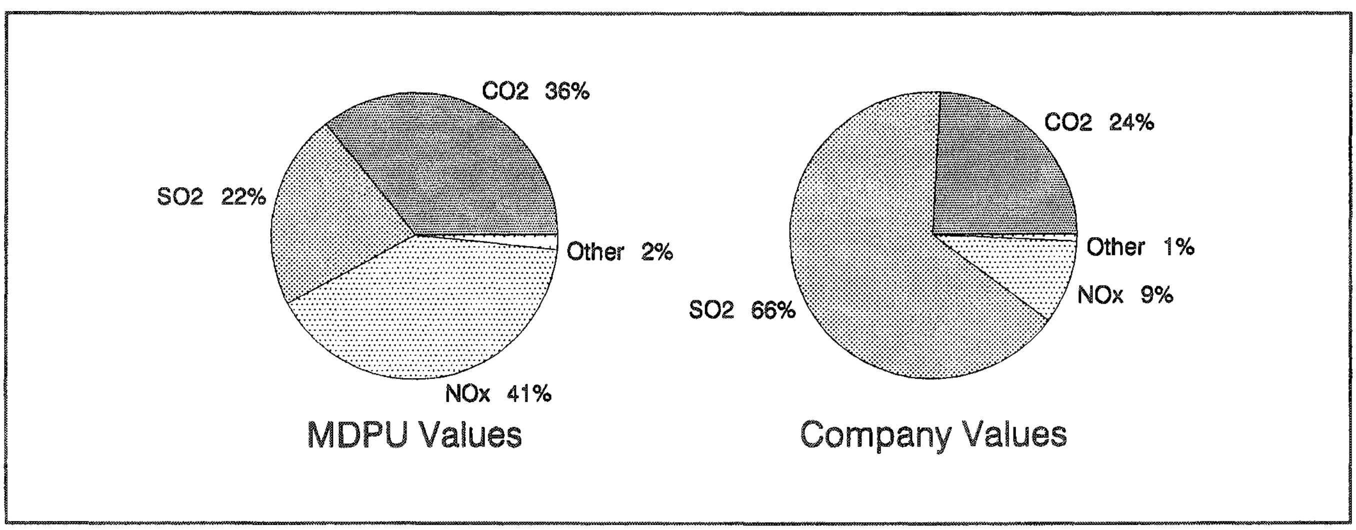

Figure 2. 1990 Index Components

- continuous environmental improvement, including a 45% reduction in weighted net air emissions by 2000 (using the Company proposed values as weights).

- rate increases at or below the level of inflation over the ten year period 1990-2000.

- an increasingly diverse power supply procured through competitive markets.

Of most interest in this paper is the environmental goal. Figure 3 illustrates the expected index reduction using the Company proposed externality values. Despite a projected 14% increase in energy production, we expect to reduce each of the three major constituents: SO_2 by 53%, a reduction of 74,000 tons per year; NOx by 50%, representing a reduction of 30,000 tons per year; and greenhouse gases by 20% (primarily CO_2, but also including CO, CH_4, N_2O, and CFCs, which have greenhouse impacts), a reduction of approximately 3 million tons per year.

The 45% index reduction will be accomplished by six different strategies. 40% out of the 45% total can be attributed to actions and plans already in place to both provide least cost energy services and comply with existing environmental laws and regulations, such as the Massachusetts Acid Rain Law and the Federal Clean Air Act. The remaining 5% improvement represents actions beyond our current commitments and goes beyond simple compliance. In more detail, the expected improvements will be:

- 11% from fuel switching and NOx control at existing units, including a switch from oil to gas at one 440 MW unit, and lower sulfur coal and oil at other units.

- 10% from gas-fired NUGs that will primarily displace oil-fired capacity

- 9% from Repowering our oil-fired Manchester Street Station as a gas-fired combined cycle unit

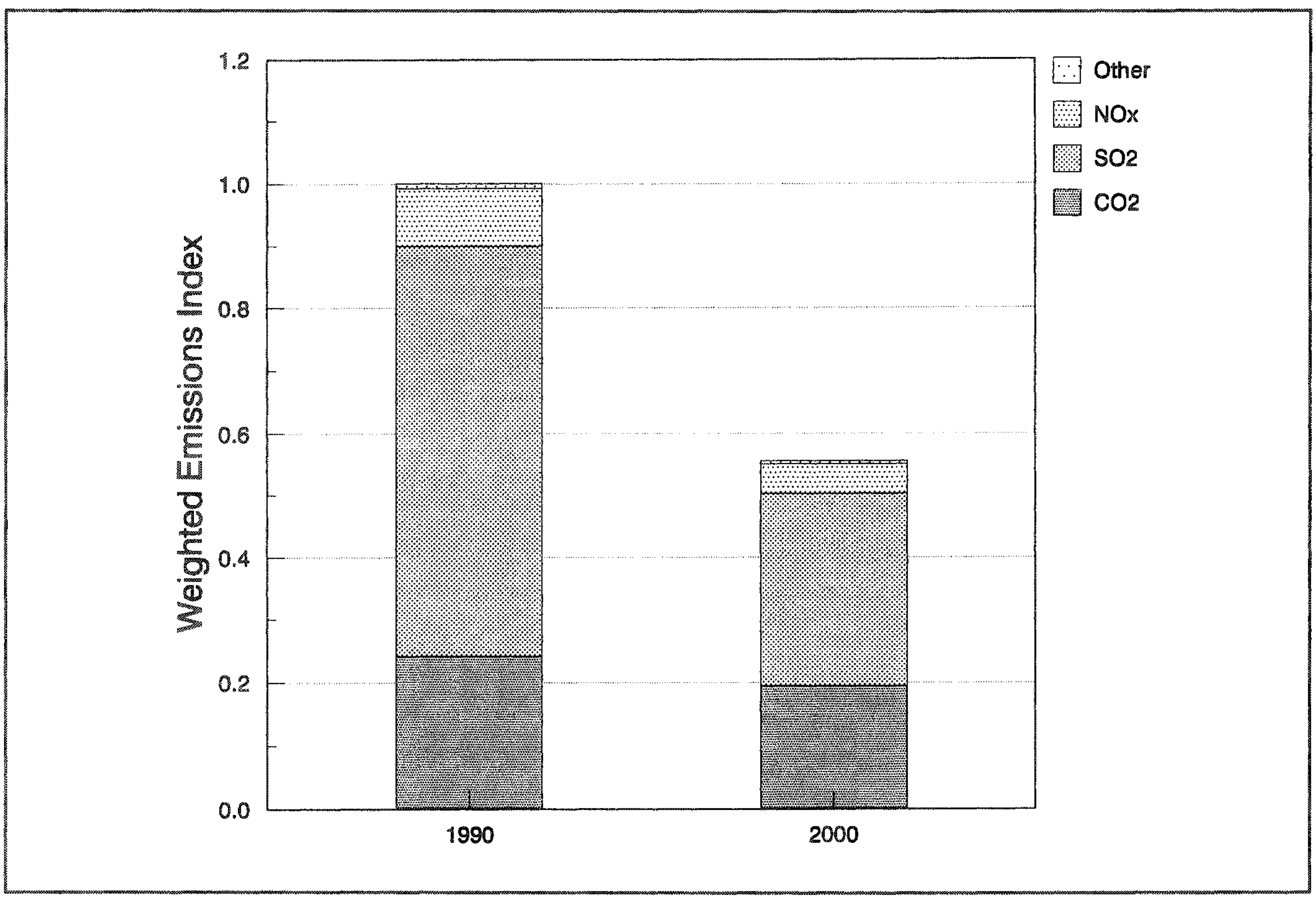

Figure 3. Emissions Improvement

- 6% from new hydro sources

- 4% from new demand-side management (DSM). It should be noted that the choice of 1990 as the base year underemphasizes the environmental contribution of DSM because it does not count the 175 MW of DSM benefits already achieved by the end of 1990.

- 5% from programs not yet determined, but that might include offsets, additional DSM, fuel conversions, or renewable technologies

We believe the additional 5% improvement can be achieved at low cost using creative ideas by taking advantage of two approaches that have worked well for New England Electric in the past: collaborative planning and competitive bidding.

The NEESPLAN 3 goals provide a clear framework under which integrated planning principles can be used to make measurable environmental progress in the most cost-effective manner possible.

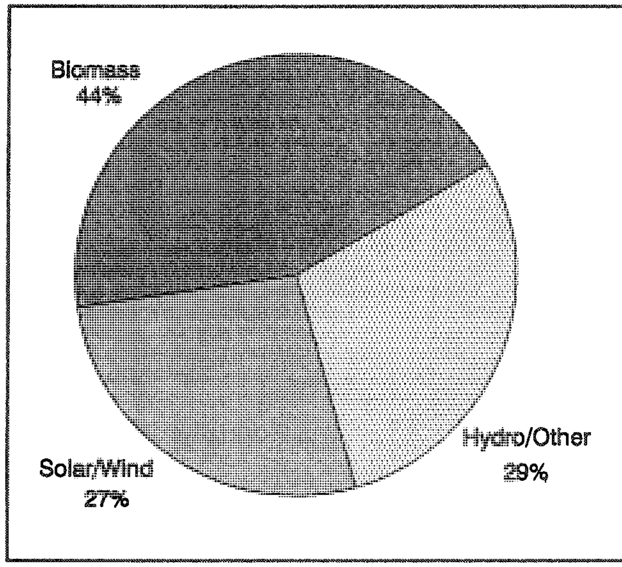

Figure 4. Green RFP Technologies

Green RFP

In December 1991, a New England Electric System subsidiary, New England Power Company (NEP), issued a "Request for Power Supply Proposals from Renewable Resource Technologies", which has come to be known within the Companies as the "Green RFP". These technologies include wind, hydro, solar, biomass, waste, and landfill gas. Despite our present lack of need for new generating capability, the Green RFP plays an important role in our environmental planning by translating the hopes, desires, speculations and research of the fledgling renewable industry into credible, market-based proposals whose performance can be verified under real world operating conditions. In April 1992, over 40 proposals were received representing over 250 MW of capacity. At the time of this writing, economic evaluations of the bids have not been completed. So far, only municipal solid waste appears generally price competitive with traditional supply side alternatives. Figure 4 illustrates the distribution of proposals by technology. Categories have been defined broadly to maintain confidentiality and preserve maximum flexibility for the Companies in upcoming negotiations.

By the end of 1992, final selections will be made and contracts awarded, based on cost, site viability, technological feasibility, financeability, developer experience, and environmental impacts. Projects are required to have on-line dates no later than January 1, 1997. By 2001, when we expect to need additional capacity and energy resources, a significant and reliable database of cost and operating characteristics will be available to inform those resource decisions. If renewable resources are shown to have significant capacity and energy potential in the northeast, and can demonstrate commercial viability, they can play an important role in reducing utility environmental impacts.

Greenhouse Gas Offsets

The threat of global warming has created great interest in reducing emissions of CO_2 and other greenhouse gases from power plants. Unfortunately, it often quite expensive or impossible to reduce the CO_2 emissions (a byproduct of combustion) from an existing power plant. It may, however, be quite feasible and relatively inexpensive to reduce CO_2 output from other sources. One of the most widely discussed CO_2 offset strategies is tree-planting. Carbon is "locked up" or "fixed" in the trees and sequestered from the atmosphere as the trees grow. Through a tree-planting program in Central America, the AES Thames coal-fired plant in Connecticut expects to fully offset its CO_2 emissions.

Given the global nature of the greenhouse effect, the opportunities for cost-effective offsets are numerous and widespread, but not without problems and risk, including measurability, durability, and legitimacy.[7] To be effective, an offset program must ensure that GHG emissions are truly and permanently avoided, or that GHGs removed from the atmosphere are permanently removed. If trees are planted only to be cut and burned in five years, any offset value is effectively negated (unless, of course, the burning displaced the combustion of fossil fuels).

With the problems and risks in mind, the New England Electric System Companies have established an Environmental Collaborative comprised of representatives of the environmental, consumer, business, and academic communities. This group will help develop, implement, and oversee our environmental initiatives, including a series of pilot programs to acquire GHG offsets which can be used to help achieve the 5% "beyond compliance" reductions in our emissions index. A number of offset strategies are currently under consideration:

- local and international forest management projects that would sequester CO_2. These projects typically fall into three categories: (1) "charity" projects, such as tropical reforestation, that are unlikely to ever be profitable, but do provide social and economic benefits in underdeveloped economies; (2) tree plantations that grow wood as a substitute for fossil fuels; and (3) more efficient logging practices that waste less biomass (which will decay and release CO_2 to the atmosphere) in the harvesting process. The latter two can frequently pay for themselves on a purely economic basis.

- recycling and/or destruction of CFCs removed from recycled appliances.

- coal mine methane recovery--certain coal formations contain significant amounts of methane that is presently released during the mining process. Methane has a greenhouse gas potential many times that of CO_2, which makes it preferable to capture the methane and burn it for productive purposes, despite the release of CO_2 during combustion.

- coal ash to cement--large amounts of carbon dioxide are emitted to create the thermal energy necessary to convert limestone ($CaCO_3$) into calcium oxide ($CaCO_2$), a principal component of concrete. Coal ash can be used as a substitute for up to 10% of the $CaCO_2$, thereby reducing energy use (and CO_2 production), improving the strength and abrasion resistance of the concrete, and reducing ash disposal problems.

- marine algae fertilization--some scientists believe that the addition of small amounts of iron to ocean waters could promote much faster growth of marine algae, which sequesters CO_2. Some land based algae alternatives may also be suitable for pilot studies.

In addition to GHG offsets, the Collaborative will also explore ways to offset NOx emissions. These are likely to include reducing NOx emissions from transportation sources, and increased use of electrotechnologies. The Collaborative's first milestone will be the establishment of several pilot programs to identify problems and establish feasibility.

Alternative Frameworks for Environmental Planning

Much attention has been devoted recently to approaches to utility planning that will reflect the cost to society of environmental externalities. Each has strengths and weaknesses measured along two principal dimensions--likely environmental improvement that will result, and expected cost of that improvement.

Compliance

The most firmly established strategy for managing environmental air quality impacts has been regulatory emission standards or limits. The utility planning strategy is simple and direct--compliance--although determining the most efficient, least expensive way to achieve compliance may be quite difficult and complicated. Under such regulatory policies, utility management is never put in the difficult position of choosing between customer interests and shareholder interests. While these interests may not be one in the same, they at least do not conflict. Under the assumption that environmental regulators are responsible to elected officials who, over time, reflect the preferences of society, the costs imposed will ultimately converge to society's value of avoiding those externalities. The costs become internalized in the price of electricity and consumer decisions are influenced accordingly.

Externality Adders

More recently, a number of state regulatory bodies have proposed that utility decision making[8] should be based on more than the direct costs of resource alternatives, and should include the indirect environmental costs, or externalities, of electric power production in the decision process for new resources. Externality "adders" that attempt to capture directly or indirectly the damage caused by emissions are combined with traditional direct resource costs to determine the total societal cost of a resource.

Without debating the particular externality values used, this approach has several flaws.

- it assumes that existing environmental regulations have failed to appropriately balance the costs of stricter standards against the benefits of reduced emissions.

- when externality adders are only incorporated into the decision process, but are not directly reflected in the price of electricity, price signals to consumers are distorted and consumer decisions will not be economically efficient. Of course, if environmental regulations have not appropriately balanced the cost of required controls against the damage caused by residual emissions, price signals may already be distorted.

- if applied only to new resource decisions, the indirect but very real impacts on the existing system are ignored. For example, adding a highly efficient gas combined cycle unit to the resource mix would likely lower total system emissions by displacing older, dirtier plants, even though the new facility would clearly have emissions of its own. Similarly, load management could be selected as the new resource, but end up displacing or deferring the new combined cycle leading to higher total system emissions. Furthermore, by focusing on new resource decisions only, there is no guarantee of environmental improvement when no new resources are being added.

- if applied to evaluate new resources against existing facilities, externalities could indicate premature obsolescence of generation and transmission assets on a massive scale. The costs of replacement would lead to rate increases that customers may be unwilling to absorb, and competitive disadvantages to industry in states where adders are used. At the same time, many cost-effective options for environmental improvement in existing plants would be lost. This formulaic approach to planning tends to overlook the difficulties of siting all the new generation and transmission that would be required.

- approaches involving externality adders tend to be accompanied by detailed regulatory processes and procedures that encourage planning by protracted litigation involving multiple parties. This is expensive, time consuming, and likely to reduce the flexibility that is critical to any successful plan.

- adding externality values to avoided costs could force utilities to pay more than necessary for power from nonutility generators. The externality premium becomes a windfall profit to the developer (or natural gas supplier) who could have been price competitive on a traditional economic basis. Environmental improvement may be gained at the highest price rather than at the lowest price.

Emission Taxes

One approach to environmental externalities is to eliminate them--internalize all the indirect costs through emission taxes. The New England Electric System Companies have offered testimony in Congress supporting the establishment of a modest (\$2/ton of CO_2 equivalent emissions) broad-based carbon tax as an efficient and workable way to start reducing CO_2 emissions. Internalization eliminates the conflicting planning objectives created by externality adders. A broad-based tax would apply to all sectors of the economy and avoid the creation of artificial incentives for noneconomic bypass. If electricity prices are raised artificially through externality adders, customers have an incentive to bypass the utility and install their own boilers or generation that may be less efficient than the utility's plant. This is an economic drain on society and may worsen environmental impact.

The biggest obstacle to emission taxes is the difficulty that such a proposal would have making it through the legislative process. This solution could work well, but it may be a long time coming.

Incentives Based on Measurable Results

A fourth approach to environmental improvement is based on the establishment of clear incentives tied to specific performance and specifically avoids any attempt to dictate particular solutions or micromanage the planning process. By establishing incentives and allowing utility planners flexibility and choice, market forces can be put to work to find environmental improvement at the lowest cost, rather than the highest. The allowances program in the acid rain title of the Clean Air Act is a good example of this type of approach. The performance goal is clear--capped SO_2 emissions. Emissions in excess of the cap will cost real money. Each utility has a clear incentive to minimize its costs, but has freedom to do so through pollution control equipment, fuel switching, allowance purchases, or other means. Initiatives in several states to provide incentives to utilities for successful DSM programs have demonstrated that this approach can be effective regulatory tool. Utilities can earn increased profit despite lower sales when specific goals are reached. This profit potential is an important motivation and has been successful in promoting demand-side policy goals.

By designing an incentive system that includes not only environmental improvement goals, but also price of electricity goals, utilities will have to work hard to identify cost-effective ways to reduce or offset emissions. If they overspend to achieve environmental objectives, prices will go up, customers will be unhappy, and shareholders will fail to earn the incentive. This approach is consistent with customer expectations. They want their utilities to do a cleaner job, but they don't want to spend a lot of money to do so.

Conclusion

A properly designed incentive based approach is an alternative means to achieve the expectations of electricity consumers--meaningful environmental improvement at a low affordable cost. The incentive plan should have at least three components: (1) a measurable total system environmental performance target, (2) a cost cap or rate index goal to ensure that the most cost-effective strategies are used, and (3) an adequate profit incentive. A well designed system based on results can provide maximum flexibility to experiment with innovative approaches like the Green RFP.

The NEES Companies believe it will be possible to significantly reduce environmental impacts at relatively low cost through fuel switching, greenhouse gas offsets, and renewable technologies. NEESPLAN 3 is a step in this direction. It establishes two measurable performance goals: weighted air emission reductions of 45% by 2000, and rate increases at or below inflation over the same period.

Acknowledgements

NEESPLAN 3 draws heavily on the work of many people at the New England Electric Companies, and also reflects the thoughtful comment of the Conservation Law Foundation. This paper draws heavily on their work, especially that of Andy Aitken, Ann Beaupre, Peter Calvert, Stan Doe, Mike Hachey, Dave Holt, Cheryl LaFleur, John Rowe, Brad Spooner, Herb Stowe, and Jeff Tranen.

Furthermore, Cheryl LaFleur and Brad Spooner provided valuable comments to the author on preliminary drafts.

Endnotes

1. Stephen S. Bernow and Donald B. Marron, *Valuation of Environmental Externalities for Energy Planning and Operations*, May 1990 Update, Tellus Institute, May 18, 1990.

2. Massachusetts Department of Public Utilities Docket No. 91-131 (Externalities Docket).

3. *Final Report on Environmental Externality Evaluation*, prepared by RCG/Hagler, Bailly, Inc. for New England Power Service Company, May, 1991.

4. Testimony of Dr. William Nordhaus, "Issues Involving the Valuation of Greenhouse Gas Emissions", submitted on behalf of Massachusetts Electric Company to the Massachusetts Department of Public Utilities, May, 1991.

5. These values were initially proposed during the summer of 1991. The Companies have continued to refine these estimates, but the values shown in Table 1, which were developed in 1991, continue to be the ones used for purposed related to NEESPLAN III.

6. Paul L. Joskow, "Dealing with Environmental Externalities: Let's Do it Right!", Edison Electric Institute, 1992.

7. Is it legitimate to count as offsets reductions in greenhouse gas emissions that result from money-making proposals? Does the definition of "offset" require that it derive from an otherwise uneconomic activity?

8. The proposals do not contemplate allowing the adders to directly affect electricity price, only decisions. If adders were applied directly to electricity prices they would essentially become emission taxes.