POTENTIAL REFINEMENTS TO FERC'S ECONOMIC METHODOLOGY — CHAPTER 4

Pursuant to the Federal Power Act (FPA) and National Environmental Policy Act (NEPA), FERC is responsible for assessing the power and non-power values of relicensing alternatives to determine which alternative would give the greatest benefit to the public.[1] As summarized in Chapter 3, this analysis currently includes quantitative estimates of power values, and generally, qualitative assessments of non-power resources. Because FERC lacks quantified values for non-power resources, FERC tends to base its relicensing decisions on both the net benefit estimates of its economic analysis and qualitative judgments about non-power factors and their impact on public welfare.

Under FERC's approach, a project alternative may receive a new license even if its estimated net benefits are negative. As FERC notes, "where our [FERC's] consideration and balancing of all public interest factors leads us to conclude that licensing a project is in the public interest, we will offer a license to the applicant, even if there appear to be negative benefits."[2] In practice, FERC's relicensing decisions reflect this approach -- a high percentage of projects are relicensed despite findings that they will result in negative net benefits. For instance, in about 40 percent (37 out of 91) of the project relicensing proceedings analyzed by David Marcus in a study for the Hydropower Reform Coalition, FERC staff calculated negative annual net benefits for the applicant-proposed or FERC staff-proposed alternatives.[3] FERC has only denied a new license for one of these projects -- Edwards Dam in Maine.[4] In the other

[1] See Chapter 2 for an overview of FERC's responsibilities under the FPA and NEPA. "Non-power" values include services provided by the river (e.g., fish and wildlife resources and recreation) and services provided by the project (e.g., water supply and flood control).

[2] FERC, *Order Issuing New License, Mead Corporation*, Project No. 2506, July 13, 1995, p. 11-12.

[3] Marcus, David, *FERC's Economic Analysis Of Hydro Projects: A Review Of Policy And Practice Since The Mead Decision*, prepared for the Hydropower Reform Coalition, March 18, 1997, p. 19.

[4] FERC, *Order Denying New License and Requiring Dam Removal*, Project No. 2389, November 25, 1997.

cases, negative economic findings have been outweighed by FERC's judgment that continued operation of projects is in the public interest.

This chapter provides a critical assessment of FERC's current economic methodology and suggests refinements designed to improve the quality of FERC's estimates and expand the usefulness of its economic analysis in relicensing decisions. It is intended to help FWS field staff: (1) recognize key problems in FERC's economic analysis that may currently bias net benefit estimates; and (2) understand potential refinements to recommend in place of FERC's current methods. Specifically, we address the following topics:

- The chapter begins by examining how effective FERC's economic methodology is at measuring the net benefits of relicensing alternatives to society as a whole, as is required under the FPA. A framework for the analysis of net benefits is presented to clarify the different perspectives of society and the applicant.

- We then define types of non-power values and discuss how the incorporation of these values into net benefit estimates would improve FERC's analysis of relicensing alternatives. This section establishes the basis for a more complete examination of non-power values in Chapter 5.

- Next, we take a closer look at key elements of FERC's economic analysis. First, we discuss some of FERC's key assumptions, such as its choices of a discount rate and baseline. Second, we propose refinements and alternative approaches for several components of FERC's methodology, including gross power benefits, costs of operation, and avoided pollution benefits.

- Finally, we provide a summary of recommended refinements to FERC's economic methodology.

TWO PERSPECTIVES ON NET BENEFITS: SOCIETY AND THE APPLICANT

The costs and benefits of relicensing alternatives often differ for society and the applicant. For example, an applicant may propose to change a project's flows in a way that increases power production during high demand (high energy value) periods to maximize profits. While this change benefits the applicant, it may also decrease downstream fishery resources -- a cost to the public. An economist would refer to the fishery resource impact as a negative "externality." An externality is a side effect borne by people not directly involved in (i.e., external to) an activity or market exchange. While an applicant generally does not factor external costs and benefits, such as environmental damage, into its financial analysis, these costs and benefits matter to society as a whole.

<u>FERC's Treatment of Applicant and Societal Perspectives</u>

Under the FPA and NEPA, FERC is required to assess the power and non-power values of a waterway to determine which relicensing alternative gives the greatest benefits to the public (see discussion in Chapter 2). While FERC's ultimate relicensing decision is made in the public interest, some guidance prepared by FERC staff suggests that economic analysis is conducted from the perspective of the applicant:

> The accounting stance of the FERC economic analysis is that of the entities generating and selling the power…. Since FERC's economic analysis of a project excludes non-power costs and benefits and doesn't adopt a "national" accounting stance, it's not what economists consider a "pure" economic analysis. Staff's economic analysis is only one consideration among many in the Commission's public interest determination. Non-power costs and benefits are dealt with, but outside the economic analysis.[5]

Despite FERC's claim that its "economic analysis is that of the entities generating and selling the power," applicants do not base their decisions about continuing operations on FERC's economic analysis. As noted above, FERC often finds that applicant-proposed and FERC staff-proposed relicensing alternatives will result in negative net economic benefits. Nonetheless, applicants have been consistently willing to continue operations under these relicensing alternatives.

FERC's current economic approach does not effectively characterize costs and benefits from a broader societal perspective either. Although non-power benefits are important to society, they are usually addressed on a qualitative basis that does not affect net benefit estimates. FERC's economic analysis could better reflect a societal perspective if FERC adopted methods for quantifying non-power benefits.

☞ Valuing and incorporating non-power benefits into the economic analysis is discussed more fully later in this chapter and throughout the remainder of the report.

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[5] FERC, *Workshop on Evaluating the Economics of Hydroelectric Projects at FERC*, Office of Hydropower Licensing, February 3, 1998, p. 1. It is worth noting here that non-power costs (i.e., the costs of environmental measures) *are* traditionally included in FERC's economic analysis (which makes it difficult to explain FERC's statement that they are not included). FERC quantifies non-power costs and incorporates them into its economic analysis as reduced power generation and/or the costs of project operation.

Clarifying Societal And Applicant Perspectives On Relicensing Alternatives

Exhibit 4-1 shows a two-by-two box designed to clarify the different points of view that society and an applicant may have on relicensing alternatives. Positive and negative signs reflect the net benefits of an alternative to society and the applicant. Four possible net benefit scenarios are described below to help guide FERC's assessment of relicensing alternatives:

Exhibit 4-1

ASSESSING THE NET BENEFITS OF A HYDROPOWER PROJECT: SOCIETAL VS. APPLICANT PERSPECTIVE

		Societal Perspective	
		+	-
Applicant Perspective	+	(a) Net benefits to society and applicant	(b) Net benefits to applicant, net losses to society
	-	(c) Net benefits to society, net losses to applicant	(d) Net losses to society and applicant

(a) Net benefits to society and applicant. Based on its statutory mandate, FERC should relicense an alternative that meets these criteria and optimizes societal benefits. The alternative should allow project operators to earn a reasonable profit because ultimately the societal benefits of an alternative can only be enjoyed if the applicant is willing to operate the project. However, if societal benefits are optimized by dam decommissioning and removal, the financial viability of the project no longer matters.

(b) Net benefits to applicant, net losses to society. FERC should not relicense an alternative in this category. The alternative should be modified to increase public net benefits to an optimum (positive) level, even if such modifications reduce benefits to the applicant.

(c) Net benefits to society, net losses to applicant. If FERC offers a new license for this alternative, the applicant will not accept it. FERC should consider alternatives that maintain positive benefits to the public but make the project more financially viable for the applicant.

(d) Net losses to society and applicant. If no project operation alternative can be identified that would result in positive net benefits for both society and the applicant, then FERC should investigate project decommissioning options.

When weighing the net benefits of relicensing alternatives, FERC needs to conduct its analysis from society's perspective, as mandated under the FPA. When an applicant's perspective is assumed, FERC runs the risk of only capturing benefits and costs relevant to the applicant's financial analysis; benefits and costs external to the applicant's analysis, such as environmental damage, may not receive adequate attention.

INTEGRATING NON-POWER BENEFITS

Natural resources such as rivers provide a variety of services of value to humans. The central element of FERC's economic analysis is a comparison of the cost of power generation at the hydropower project with the cost of obtaining power from an alternative source. That is, the analysis seeks to determine the societal net benefit of generating power from the project rather than from another source. In this way, FERC's analysis seeks to value one key service flow provided by the river: efficient generation of power.

Rivers may provide recreational opportunities and other services that humans value. These service flows are often affected by dam operation. As we have noted, FERC's analysis acknowledges and often characterizes these non-power benefits in qualitative terms, but generally does not value these services in monetary terms. Below, we briefly describe some of the key categories of non-power benefits. The objective is to begin our explanation of how economic analysis can be used to characterize the value that society places on these benefits and how these values can be integrated into the overall estimation of net project benefits.

When economists place a value on natural resources, they are typically valuing the goods and services that the resources provide. These goods and services are diverse and contribute to the overall welfare of individuals who consume them. Individuals may consume the goods and services directly; for example, a clean, flowing river may produce goods such as drinking water and services such as recreational opportunities. Likewise, individuals may consume the services indirectly; for example, the clean flowing river may produce healthy ecosystems that provide habitat for resident fish and plant species.

Economists have made many attempts to break down and categorize the various goods and services that flow from natural resources. This task is complicated by the complexity of some of the service flows and the overlapping nature of many of the categories. While no single taxonomy of goods and services is perfect, one possible breakout is provided in Exhibit 4-2. As shown, a fundamental distinction is made between "use values" and "non-use values." Below, we define and discuss these two components of non-power benefits.

Exhibit 4-2

CATEGORIZATION OF GOODS AND SERVICES PROVIDED BY RIVER RESOURCES

Use Value	Market Goods and Services	• Water supply (municipal, agricultural, industrial) • Commercial fishing
	Non-Market Goods and Services	• Instream recreation (fishing, rafting) • Near-stream recreation (camping, wildlife viewing) • Aesthetic enjoyment • Ecological services
Non-Use Value		• Existence value • Bequest value • Option value

Use Value

Use values associated with natural resources include values for goods and services that humans realize through direct or indirect use of the resource. In the case of hydropower relicensing, some of the relevant non-power benefits will involve river-based resources that are traded in conventional markets. For example, humans may take market goods such as drinking water, irrigation water, or commercially sold fish from the river.

A class of potentially more important use values are the non-market goods and services that river resources directly provide. Non-market goods and services are not traded in conventional markets with buyers and sellers and established prices. However, individuals hold values for many of these goods and services in much the same way as they do for commercially traded goods and services. For example, a recreational angler may value the opportunity to fish in a pristine stream, despite the fact that he or she pays no explicit price for this activity.

Finally, some non-market resource services are consumed indirectly. Most notably, certain ecological functions are valuable in that they enable the kinds of direct uses discussed above. For instance, the pollution filtering services provided by wetlands may help maintain healthy ecological conditions in a river, thereby enabling water withdrawals and recreational uses potentially precluded by poor water quality.[6]

Non- Use Value

In addition to use values, economists consider economic benefits that accrue to those who do not directly or currently use the resource and perhaps never intend to do so. Economists refer to these benefits using several different terms, including non-use value, intrinsic value, existence value, and passive use value.[7] To avoid confusion, we adopt the term non-use value to refer to this class of economic benefits.

Serious consideration of non-use value in economic analysis can be traced back to the economic theorist John Krutilla.[8] Krutilla reasoned that for unique natural resources, the economic loss of these resources may be incurred by a group considerably larger than current

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[6] Appendix A introduces modeling approaches for estimating potential regional economic impacts of relicensing alternatives (i.e., changes in output, employment, and taxes of regional businesses).

[7] For a general discussion of non-use value and its applicability to economic analysis, see Kopp, Raymond J., and V. Kerry Smith, *Valuing Natural Assets: The Economics of Natural Resource Damage Assessment*, Resources For the Future, 1993.

[8] Krutilla, John V., "Conservation Reconsidered," *American Economic Review*, Vol. 57, 1967, p. 777-786.

users.[9] Krutilla provided the example that for "the spiritual descendants of John Muir, the present members of the Sierra Club, the Wilderness Society, National Wildlife Federation, Audubon Society and others to whom the loss of a species or the disfigurement of a scenic area causes acute distress and a sense of genuine relative impoverishment," the existence of natural wonders and fragile ecosystems may indeed represent a significant portion of their wealth. Krutilla contended that by considering only the economic benefits accruing to current resource users in the economic analysis of unique natural resources, economists may significantly underestimate their economic value.

Subsequent to the publication of Krutilla's paper, economists began to further characterize and explore non-use value. As part of this research, economists considered the underlying motivations for non-use value. These motivations or categories include:

- Existence value, i.e., knowledge of continued existence of the resource;
- Bequest value, i.e., preserving the resource for future generations; and
- Option value, i.e., having the option to use the resource in the future.

During the 1980s, existence, bequest, and option values were considered separate entities, resulting in several studies that attempted to separate out portions of non-use value according to these motivations. While these motivations are still discussed in the literature, the emphasis is now on simply measuring total value, regardless of motivation. The concept of non-use value is now accepted by most economists, is officially recognized by many state and federal agencies, and is also legally recognized in federal as well as in many state courts.[10]

☞ For some FERC relicensing cases, non-use values may be relevant and significant. The rivers involved often offer unique preservation or restoration opportunities. Chapter 5 includes a discussion of economic valuation techniques used to measure non-use values. Chapter 6 summarizes the results of economic studies that estimate fairly large non-use values for resources related to dam removal or modification.

Incorporating Non-Power Benefits In FERC's Economic Analysis

Estimating the use and non-use values of non-power resources would improve FERC's relicensing decisions in two ways. First, FERC could develop better staff-recommended alternatives by truly weighing the benefits and costs of different proposed environmental

[9] Krutilla explained that absolute uniqueness was not a requirement for his arguments to hold. The term uniqueness can apply at the local level even though substitute resources exist elsewhere.

[10] For discussions on various legal aspects of non-use value, see Kopp and Smith, 1993, op cit.

measures. Only measures with net benefits would be included as part of a proposed relicensing alternative. Second, FERC's economic analysis would provide a stronger indicator of which relicensing alternative is in the public interest. FERC could rely less on qualitative judgments. These improvements are discussed in more detail below.

Choosing Among Proposed Environmental Measures

Currently, FERC chooses environmental measures for its recommended relicensing alternative based on quantified costs and qualitative judgments about benefits.[11] Typically, environmental measures proposed by other participants in relicensing proceedings are included in the recommended alternative if the costs are expected to be small, whether or not the measures have net benefits. FERC becomes more concerned about the benefits and costs of an environmental measure if its costs represent more than ten percent of a project's annual power benefits. As noted in Chapter 3, a FERC policy directive instructs staff that "as a rough, internal-only practical guideline, Section 10(j) conditions should be subjected to a cost-benefit analysis where the cost of the condition exceeds 10 percent of the project's power benefits."

Despite this policy, an analysis of more than 90 relicensing proceedings undertaken by Marcus revealed that "mitigation measures are rejected because they have 'high' costs, without any analysis of whether they may also have high benefits."[12] Marcus also found that FERC rejected about two-thirds of the environmental measures with costs greater than ten percent of annual power benefits.[13] Of the measures accepted by FERC, several were mandatory conditions pursuant to FPA sections 4(e) and/or 18.

Under a strict benefit-cost test, as long as an environmental measure's benefits outweigh its costs, it should be included as part of the recommended relicensing alternative. This approach improves the overall net benefit of the project from a societal perspective. For example, if a fish passage measure costs $1 million to implement but yields $2 million in recreational fishing benefits, the project's net value is increased by addition of the measure.

☞ We recommend that the economic analysis quantify use and non-use values of environmental measures so that benefits can be weighed against costs. This valuation should be performed regardless of whether costs are greater than ten percent of the project's power benefits. Otherwise, FERC may reject measures with net benefits, or include measures with net costs.

[11] As noted in Chapter 2, measures prescribed by resource agencies under FPA Section 4(e) or Section 18 *must* be included in the recommended relicensing alternative, regardless of their costs and benefits.

[12] Marcus, op cit., p. 12

[13] Marcus, op cit., p. 13.

Choosing Among Relicensing Alternatives

Under FERC's current economic approach, FERC often recommends alternatives that, according to its own economic analysis, do not offer the highest annual net benefits. This occurs because, while FERC includes the cost of implementing environmental measures in its net benefit estimates, FERC does not incorporate the increased use and non-use values of improved non-power resources. Therefore, relicensing alternatives that include environmental measures usually look less economically beneficial than the no-action alternative. For example, FERC found annual net benefits of $5.2 million for the North Georgia project under the no-action alternative.[14] In comparison, the applicant's proposal offered $4.8 million in annual net benefits, while FERC staff recommended a proposal with $4.7 million in benefits (see Exhibit 3-7, Chapter 3). The applicant and FERC alternatives offered lower annual net benefits because they included the costs to mitigate damages to non-power resources but did not incorporate the benefits of these measures.

FERC's economic analysis would be a stronger indicator of which relicensing alternative is in the public interest if improvements to non-power resources were valued and incorporated in the analysis. For instance, FERC's relicensing alternative for the North Georgia project proposes (among other conditions):

- Minimum flows of 35 cfs year-round;
- Five weekends of whitewater boating flows, 500 cfs on Saturdays and 700 cfs on Sundays;
- Additional aesthetic flow releases in the spring, late summer, and fall, of 200 cfs during daylight hours for specified weekends; and
- Improved public access for fishing and whitewater users at Lake Tugalo (e.g., boat ramp, toilet accommodations, provisions for waste control).[15]

The increased opportunities for whitewater boating and recreational fishing, as well as improvements to aesthetic values (e.g., waterfall viewing), provided by these measures may exceed their estimated $500,000 in annual costs. By using techniques described in Chapters 5 and 6 of this report, FERC could attempt to quantify these values. For instance, if FERC estimated the benefits of these measures to be $600,000 to $800,000 annually, its economic analysis would support its relicensing decision -- FERC's recommended alternative would provide annual benefits of $5.3-$5.5 million while the no-action alternative would offer benefits of only $5.2 million.

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[14] FERC, *Final Environmental Impact Statement, North Georgia Hydroelectric Project*, FEIS-0098, June 1996, p. 5-9.

[15] FERC, Ibid., p. 5-10.

☞ Including the value of environmental benefits in annual net benefit estimates would identify relicensing alternatives that provide the greatest benefits to the public. Chapters 5 and 6 provide information on the basic analytic methods available for valuing environmental benefits.

REVIEW OF FERC'S KEY ASSUMPTIONS

FERC's discount rate and baseline for analysis may bias relicensing decisions against environmental measures in favor of power generation. In this section, we discuss the potential reasons for this bias and suggest changes and refinements to FERC's assumptions.

Discount Rate

The choice of a discount rate can significantly affect net benefit estimates. As discussed in Chapter 3, the discount rate reflects the "time value of money" -- i.e., a dollar paid today is worth more than a dollar paid a year into the future. Therefore, applying a higher discount rate will reduce the present value of future benefits and costs more than if a lower rate were used (see Exhibit 3-2). More important for this discussion, a higher rate will tend to reduce the net present value of relicensing alternatives with costs in the near-term and benefits occurring several years in the future. Since environmental measures often require up-front costs in return for future benefits (e.g., the recovery of an ecosystem), the use of a high discount rate can bias decisions about relicensing conditions against environmental measures.[16]

FERC's Discount Rate

FERC uses a ten-percent discount rate in its economic analyses of proposed relicensing alternatives. This is a private discount rate reflecting applicants' weighted average cost of capital (WACC). The WACC represents the cost of a company's debt and equity weighted by the value of each source of financing. Companies use the WACC for discounting because it represents the rate of return that must be earned to repay debt holders (e.g., banks, bondholders) and satisfy equity owners (e.g., partners, stock holders).

As FERC notes, an estimate of applicants' WACC is used to discount the benefits and costs associated with relicensing alternatives:

> The 10 percent discount rate is the average weighted cost for capital for investor-owned electric utilities based on the [FERC] staff's analysis of projects around the country. We [FERC] attempt

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[16] As noted in Chapter 3, the number of years included in an economic analysis can also affect the net benefits of relicensing alternatives. Some alternatives, such as dam removal, may result in long-term net benefits that continue to be grow beyond the 30-year period of FERC's analysis. Ignoring these long-term benefits may make such alternatives relatively less attractive.

> to use the 10 percent discount rate, where appropriate, in all our economic analyses so that the results can be compared to each other.[17]

FERC applies the ten-percent discount rate in its economic analysis even when the applicant uses a different discount rate for its own financial analysis. For instance, FERC applied a ten percent discount rate in its analysis of the Condit project even though the applicant (Pacificorp) was using a discount rate of 8.58 to 8.81 percent.[18]

Private Discount Rate vs. Social Discount Rate

While a private discount rate is the appropriate discount rate to use for analyzing private investments, it may not be appropriate in assessing benefits and costs to the public, as with hydropower licensing. By licensing a private entity to develop a waterway, FERC is making an investment choice with a public resource.

Although government agencies differ over whether private or social discount rates should be applied to public investments, all agencies recommend using a discount rate lower than the discount rate currently used by FERC. At the high end of the range, the U.S. Office of Management and Budget (OMB) recommends the use of a private discount rate of seven percent for evaluating public investments.

> Constant-dollar benefit-cost analyses of proposed [public] investments and regulations should report net present value and other outcomes determined using a real discount rate of 7 percent. This rate approximates the marginal pretax rate of return on an average investment in the private sector in recent years.[19]

The Department of the Interior defers to OMB's guidance on discounting. DOI's final rule on discounting for the purposes of natural resource damage assessment states that "the discount rate to be used is that specified in Office of Management and Budget (OMB) Circular A-94 Revised."[20]

Other government agencies, such as the Congressional Budget Office and General Accounting Office, recommend using a social discount rate to discount the benefits and costs of

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[17] FERC, *Final Environmental Impact Statement, Condit Hydroelectric Project*, FEIS-0103, October 1996, p. I-171. The average weighted cost of capital reflects applicants' average weighted cost of debt and equity.

[18] FERC, Ibid.

[19] Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, Circular No. A-94, October 29, 1992, p. 9. A "real" discount rate refers to a discount rate that has already been adjusted for inflation.

[20] 43 CFR Section 11.84(e)(2).

public investments.[21] Unlike private discount rates, which equal the rate of return on investment, social discount rates reflect the rate at which society is willing to trade off present consumption for future consumption. Social discount rates are based on the notion that most individuals place more weight on consumption by future generations than is indicated by the rate of return on private investment.[22] Therefore, to increase the value of future benefits, social discount rates will tend to be lower than private discount rates. The Congressional Budget Office has specified two percent as the best estimate of the social discount rate, with sensitivity analysis of estimates based on rates of zero percent and four percent.[23] Several studies support the Congressional Budget Office's estimate.[24]

Refinements To FERC's Discounting Approach

The ten percent discount rate that FERC applies in its economic analysis is probably too high. Given the discount rates recommended by other federal agencies, using discount rates of two percent (lower bound) and seven percent (upper bound) is more appropriate. If the results of FERC's relicensing analysis are insensitive to changes in the discount rate (e.g., annual net benefits are positive under both a two percent and seven percent discount rate), there is no need to determine which discount rate is more appropriate. If the results change substantially under each discount rate, a more thorough evaluation of the relicensing alternative may be necessary to determine if it provides the greatest benefits to the public.

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[21] Hartman, Robert W., (Congressional Budget Office), "One Thousand Points of Light Seeking a Number: A Case Study of CBO's Search for a Discount Rate Policy," *Journal of Environmental Economics and Management*, Vol. 18, No. 2, Part 2, 1990. U.S. General Accounting Office, *Discount Rate Policy*, GAO/OCE-17.1.1, 1991.

[22] An extensive literature on social discount rates exists. For more recent contributions, see: (1) Freeman, A. Myrick III, *The Measurement of Environmental and Resource Values*, Washington, DC: Resources for the Future, 1993; (2) Arnold, Frank S., *Discounting from a Social Perspective: First Principles*, prepared for the Office of Toxic Substances, U.S. Environmental Protection Agency, 1986; (3) Lind, Robert C., "Reassessing the Government's Discount Rate Policy in Light of New Theory and Data in a World Economy with a High Degree of Capital Mobility," *Journal of Environmental Economics and Management*, Vol. 18, No. 2, Part 2, 1990; and (4) Lyon, Randolph M., "Federal Discount Rate Policy, the Shadow Price of Capital, and Challenges for Reforms," *Journal of Environmental Economics and Management*, Vol. 18, No. 2, Part 2, 1990.

[23] Hartman, Robert W., 1990, op cit., p. S-4.

[24] The following studies suggest that the social discount rate ranges from about zero percent to four percent. Lind, Robert C., "A Primer on the Major Issues Relating to the Discount Rate for Evaluating National Energy Options," in Robert C. Lind, ed., *Discounting for Time and Risk in Energy Policy,* Washington, DC: Johns Hopkins University Press for Resources for the Future, 1982. Barro, Robert J., et al., *World Real Interest Rates*, Working Paper No. 3317, Cambridge, MA: National Bureau of Economic Research, 1990.

☞ We recommend that the economic analysis incorporate the following changes:

1. Continue assuming financing costs that reflect the private cost of capital when annualizing a project's capital costs over the proposed term of a new license. A ten percent rate may still be appropriate, although specific consideration of each applicant's cost of capital would be preferable.

2. Apply discount rates of two percent and seven percent to discount all cost and benefit values to their present worth.

3. Levelize annual costs and benefits using discount rates of two percent and seven percent.

4. If annual net benefits differ significantly under a two percent discount rate and a seven percent discount rate, determine which measures within the relicensing alternative are most sensitive to variation in the discount rate and evaluate their benefits to the public more thoroughly.

An Illustration of Why Discount Rates Matter In Relicensing

Suppose resource agencies recommend under FPA Section 10(j) that a hydropower project increase its minimum flows to improve the downstream fish habitat. As shown in Exhibit 4-3, the estimated annual cost of this measure is $50,000 in reduced power values. Because the recovery of fish habitat takes time, it is estimated that the benefits of improved fishery resources will not be recognized until three years after increased flows have been implemented. Fishery resources and the associated benefits to recreational fishing are expected to improve for several years until, in the tenth year, they level off at $80,000 per year.

Exhibit 4-4 shows the levelized annual net benefits of this hypothetical environmental measure under discount rates of two percent, seven percent, and ten percent. Under a two percent discount rate, the measure to increase minimum flows has annual net benefits of more than $10,000. Although applying a seven percent discount rate reduces annual net benefits to about $2,000, net benefits remain positive, so the measure should be adopted. However, under FERC's current discount rate of ten percent, the measure is expected to result in negative annual net benefits of about $3,000. FERC's analysis might lead to the rejection of the measure, even though the measure yields positive net benefits under more accepted discounting practices.

Exhibit 4-3

ANNUAL COSTS AND BENEFITS OF A HYPOTHETICAL ENVIRONMENTAL MEASURE

Year	Annual Costs	Annual Benefits
1	$50,000	$0
2	$50,000	$0
3	$50,000	$10,000
4	$50,000	$20,000
5	$50,000	$30,000
6	$50,000	$40,000
7	$50,000	$50,000
8	$50,000	$60,000
9	$50,000	$70,000
10-30	$50,000	$80,000

Exhibit 4-4

LEVELIZED ANNUAL NET BENEFITS OF A HYPOTHETICAL ENVIRONMENTAL MEASURE UNDER DIFFERENT DISCOUNT RATE ASSUMPTIONS

Discount Rate	Levelized Annual Cost	Levelized Annual Benefit	Levelized Annual Net Benefit
2 Percent	$50,000	$61,735	$11,735
7 Percent	$50,000	$52,148	$2,148
10 Percent	$50,000	$46,584	-$3,416

Baseline for Analysis

FERC has established that the appropriate baseline to use for relicensing proceedings is *the current operation of the project under its existing license and the current waterway environment*.[25] Against this baseline, referred to as the "no-action" alternative, FERC evaluates competing uses of a waterway. Several government departments and non-governmental organizations, including DOI, Department of Commerce, and the Hydropower Reform Coalition, argue that FERC's baseline is legally and scientifically deficient. They maintain that both the Federal Power Act and National Environmental Policy Act require FERC to use a "without the project" baseline (i.e., conditions that would prevail after the project is removed).[26]

[25] City of Tacoma, 67 FERC ¶ 61,152, 1994.

[26] See *American Rivers v. FERC*, United States Court of Appeals, Ninth Circuit, No. 98-70079. For additional arguments, see: (1) Department of the Interior and Department of Commerce, *Petition for Rehearing, Cushman Hydroelectric Project*, Project No. 460-006, 1994; (2) Public Service Co. of New Hampshire, 68 FERC ¶ 61,177, 1994; and (3) Hydropower Reform Coalition, *Environmental "Baseline" in FERC Relicensing*, May 1, 1997.

"Without the Project" vs. Existing Conditions

DOI and the Department of Commerce (hereafter referred to as "the Departments") contend that a "without the project" baseline is legally supported and consistent with FERC's responsibility to evaluate relicensing alternatives in the public interest.[27] By adopting its current baseline, the Departments argue that:

> The Commission accepts the damage done to date as an irreversible *fait accompli*. Thus, the Commission will be left with nothing more to do than analyze the residual environmental values that remain untouched against even further environmental harm. The result will be that, instead of providing protection, mitigation, and enhancement of natural resources, the Commission will simply decide how much additional harm is acceptable. This is clearly not what Congress intended in either the FPA, as amended by ECPA, or NEPA.[28]

In addition, the Departments point out that the Ninth Circuit Court's ruling in the Yakima case supports the assumption of a "without the project" baseline.

> Relicensing … is more akin to an irreversible and irretrievable commitment of a public resource than a mere continuation of the status quo. Simply because the same resource had been committed in the past does not make relicensing a phase in a continuous activity. Relicensing involves a new commitment of the resource….[29]

Finally, the Departments question how FERC can fulfill its responsibility to consider decommissioning options in relicensing proceedings if it does not conduct an environmental review of a waterway's "without the project" conditions.[30] The Departments maintain that FERC must conduct such an evaluation in order to assess the potential benefits of decommissioning and determine whether decommissioning is the alternative most in the public interest.

Implications of FERC's Current Baseline and Recommended Approach

If FERC continues to evaluate projects based on the current baseline, FERC should at minimum consider the potential for bias in its analysis and adjust its licensing conditions accordingly. As noted in Chapter 3, the current baseline can bias FERC's environmental review in two ways.[31] First, it can affect the *quantity or level* of environmental impacts attributable to

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[27] Stolfo, Judith M., Staff Attorney, Office of the Regional Solicitor, "Comments on the Draft *Economic Analysis for Hydropower Licensing: Guidance and Alternative Methods,*" Memorandum to Ron Lambertson, Regional Director, U.S. Fish and Wildlife Service, Hadley, MA, September 11, 1998.

[28] Department of the Interior and Department of Commerce, p. 24.

[29] *Yakima Indian Nation v. FERC,* 746 F. 2d. at 476-477.

[30] Department of the Interior and Department of Commerce, p. 30.

[31] Hydropower Reform Coalition, 1997, p. 2-3.

the project -- environmental impacts are less under the current baseline compared to a "without the project" baseline. To illustrate, consider that FERC views environmental measures under the current baseline as environmental "enhancements," whereas under a "without the project" these same measures would be more appropriately viewed as mitigation of resource losses caused by the project.

Second, the baseline affects the *type* of environmental measures used to offset project impacts. Under the current baseline, measures to improve reservoir fisheries and measures to restore the ecological health of the river may be viewed as similar environmental "enhancements." If a "without the project" baseline were employed, however, mitigating resource losses by restoring the ecological health of the river would take precedence over improving the existing reservoir environment.

To evaluate the potential public benefits of river restoration and ensure that measures to mitigate resource losses receive due consideration, it is essential to have an understanding of what the conditions of the river and riverine environment would be without the project. For example, assessing a fishery's productivity under "without the project" conditions may be useful for estimating potential recreational and commercial fishing benefits under alternatives that improve fish passage or habitat, especially decommissioning. Such "without the project" information would improve FERC's analysis of environmental measures.

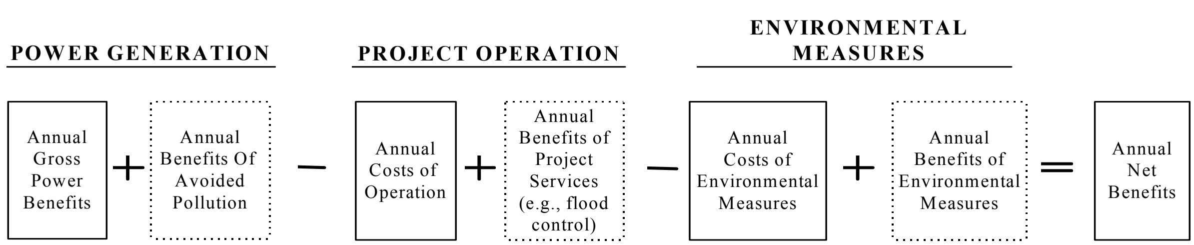
☞ We recommend that parties involved in relicensing use "without the project" conditions as a reference point for identifying potential non-power benefits associated with the river resource.

RECOMMENDED REFINEMENTS TO CURRENTLY QUANTIFIED ESTIMATES

To help guide the discussion of potential refinements to FERC's economic methodology, Exhibit 4-5 reintroduces the equation of six benefit and cost components. FERC currently quantifies estimates for gross power benefits, avoided pollution benefits, costs of operations, and costs of environmental measures. Below, we propose improvements to FERC's analysis of three of these components: gross power benefits, costs of operation, and avoided pollution benefits.

Exhibit 4-5

OVERVIEW OF FERC'S ECONOMIC METHODOLOGY*



* Solid-line box indicates quantified estimate. Dotted-line box indicates items either assessed qualitatively or quantified but left out of FERC's net benefit calcultaion.

Annual Gross Power Benefits

To estimate the gross power benefits of a project, FERC typically applies a replacement cost approach using cost information from the "most likely thermal alternative" or simulated market prices (as discussed in Chapter 3). Under the replacement cost approach, gross power benefits are represented by the cost that would be incurred to replace a project's current energy and dependable capacity values with energy and equally reliable capacity from an alternative source. To establish these replacement energy and capacity values, FERC either estimates the costs (i.e., construction, O&M, and fuel costs) to build and operate a new generation facility, or develops market price information by modeling simulations of the regional power market.[32]

Because of the challenges of developing simulated market prices, FERC usually applies the most likely thermal alternative approach to estimate a project's gross power benefits. We have reviewed this approach and identified several important areas where FERC's assumptions may be flawed and replacement cost estimates could be improved. A number of our conclusions draw on a recent analysis of FERC's approach conducted by David Marcus for the Hydropower Reform Coalition.[33]

Energy Demand May Be Overstated

Analysis of energy demand sets the stage for the calculation of power benefits. If energy demand is projected to be high, replacement energy and capacity costs will be correspondingly high, making the value of the existing project's power benefits greater. Therefore, it may be in the applicant's interest to project high energy demand (especially if FERC is considering decommissioning options). Traditionally, FERC has relied heavily on the applicant's self-reported analysis of energy demand.[34] Based on this analysis, FERC usually concludes that a new generation facility must be constructed to replace any reductions in the hydropower project's energy and capacity.

As illustrated by the analysis of Condit (see text box below), whether the total replacement of a project's energy and capacity losses is necessary depends on the region's energy demand/surplus. If a region has excess capacity (and the applicant can purchase this power), FERC should not assume that the immediate construction of replacement capacity is necessary. The applicant can purchase replacement energy from an existing source elsewhere in the region for less than the cost of constructing a new generation facility. The cost of

[32] Typically, a new generation facility is assumed to be either a combined cycle plant (CC) or combustion turbine plant (CT).

[33] Marcus, op cit.

[34] Marcus, op cit., p. 10. Also see Meyer Resources Inc., *An Analysis of: "FERC/DEIS-0103 -- Condit Hydroelectric Project -- FERC 2342-005 Washington",* Davis, CA: prepared for American Rivers and The Yakima Indian Nation, 1996, p. 13.

replacement capacity should be based on some point in the future when the additional capacity is needed.

**ASSESSING THE NEED FOR POWER IN THE PACIFIC NORTHWEST:
ENERGY DEMAND OR SURPLUS**

In the draft environmental impact statement (DEIS) for the Condit project in Washington state, FERC primarily relies on information from the Pacific Northwest Utilities Conference Committee (PNUCC) to assess regional energy demand. The DEIS cites data from this source that suggests energy demand in the northwest region exceeded supply in 1995, and Pacificorp will be in an energy supply deficit by 2003.[35]

Meyer Resources argues that the actual energy picture in the northwest area is substantially different than what is described in the DEIS. Meyer examined the PNUCC and Pacificorp reports, as well as energy demand projections made by other utilities in the region, and found significant evidence that the region has a current energy surplus that is likely to continue for several years.

> "Bonneville Power Administration (BPA), the largest power-related agency in the Pacific Northwest, reports current energy surpluses for the region. BPA has been scaling back its appraisal of potential energy demand for its power in the region since 1994, principally due to anticipated cutbacks in demand from large industrial customers, increases in industrial cogeneration in the region, and due to energy conservation. In fact on the basis of predicted existing overcapacity of energy resources, BPA canceled a large scale energy supply option with British Columbia during 1995."[36]

BPA's capacity divestiture is a strong indication of regional overcapacity. Citing this type of evidence, Meyer suggests that the Condit DEIS does not provide an accurate or balanced analysis of energy demand and supply conditions in the Pacific Northwest. Rather, FERC has relied on "a single contrary PNUCC document -- based on self-reported load and resource information by the same public and private utilities that are the subject of FERC regulation at hearings such as Condit."[37]

If regional overcapacity exists, Pacificorp can simply replace any power losses due to relicensing conditions with power purchased from another existing source; the construction of new capacity is not necessary. Pacificorp is connected to the northwest regional power grid, so available surplus power in the region can be purchased by Pacificorp at the region's least cost. Indeed, this is the approach BPA is taking. "For the immediate future, BPA's resource strategy is to rely on power purchases to serve any incremental power needs."[38]

☞ Comments submitted to environmental impact statements often call attention to the potential for applicants to bias analyses of energy demand

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[35] FERC, *Draft Environmental Impact Statement, Condit Hydroelectric Project*, DEIS-0103, 1995, p. 1-3 to 1-5, as cited in Meyer Resources Inc., p. 13.

[36] Bonneville Power Administration, *Business Plan in Brief*, June 1994, as cited in Meyer Resources Inc., p. 13-14.

[37] Meyer Resources Inc., op cit., p. 15.

[38] Bonneville Power Administration, *Pacific Northwest Loads and Resources Study White Book*, 1995, p. 6, as cited in Meyer Resources Inc., p. 13.

in their interest. To guard against this bias, FERC or other parties involved in the relicensing process should seek an independent analysis of how energy demand and capacity needs affect replacement energy and capacity estimates. Forecasts of energy demand are available from the Department of Energy's Energy Information Administration.[39] In addition, forecasts may be available from local utilities, utility associations, and consumer groups in the region.

Fuel Costs May Be Overstated

Review of FERC analyses suggests that fuel costs may sometimes be overstated. Marcus hypothesizes that fuel prices may have been overstated in recent relicensing proceedings simply because of "regulatory lag" -- the length of time from the initiation of the relicensing proceeding to its conclusion.[40] Data initially cited in FERC's analysis could become several years out of date by the time the analysis is finalized. Because fuel prices can change considerably over time, this can cause substantial errors. Marcus speculates that over the course of recent proceedings, FERC may have failed to update its initial fuel price data with more current (lower) fuel prices. By applying higher fuel prices than the current prices, FERC biases replacement costs upward and thereby increases the gross power benefits of the project under consideration.

However, as Marcus notes, FERC also often understates the likely heat rates of new generation facilities.[41] Heat rate is a BTU per kWh measure of power generation efficiency; the lower the heat rate, the greater the efficiency of the plant. Marcus points out that in several cases FERC has assumed a heat rate of 6,200 BTU/kWh, which is beyond current technology.[42] This assumption lowers the costs of the thermal alternative, which partially offsets FERC's fuel price assumptions.

☞ To improve the accuracy of gross power benefit estimates, we recommend that the economic analysis use up-to-date fuel cost data and assume a higher (less efficient) heat rate for new generation facilities, in the range of 6,500-7,500 BTU/kWh.

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[39] For energy demand forecasts from the Department of Energy's Energy Information Administration, see their website at: "http://www.eia.doe.gov/forecasting_index.html"

[40] Marcus, op cit., p. 24.

[41] Marcus, op cit., p. 11.

[42] Heat rates range from 6,500 to 7,500 BTU/kWh for combined cycle plants, see *1996 Gas Turbine World Handbook.*

Length Of Plant Life May Be Understated

Marcus also argues that in some cases FERC has understated the length of plant life for a new generation facility. Typically, FERC assumes that a new generation facility will be either a combined cycle plant (CC) or combustion turbine plant (CT). In its economic analysis, FERC assumes a less-than-30-year project life for these alternatives, which Marcus finds unrealistic. He notes that current CC and CT plants are kept in service more than 30 years, so a new generation facility would probably not have a shorter life than these older plants.[43] Assuming that the thermal alternative would need to be replaced during the 30-year relicensing period biases replacement costs upward.

☞ We recommend that the economic analysis assume a longer plant life -- perhaps 30 years -- for new generation facilities. This will reduce the cost of replacing the current project, thereby reducing gross power benefits, and the overall project net benefit.

Use of Market Price Information

As deregulation and integration of power markets continues, market prices for energy will become increasingly available. Where possible, FERC should use market prices to evaluate replacement energy costs rather than estimate these costs based on the construction and operating costs of the most likely thermal alternative. By using market prices for replacement generation, FERC could avoid all of the problems (discussed above) associated with identifying a proxy generation source and pricing it.

Although competitive electricity markets are still in their infancy, these markets are expected to grow. Electricity will become a commodity like natural gas, petroleum products (e.g., crude oil, heating oil, gasoline), and other energy products. To provide a glimpse of the direction in which competitive electricity markets are headed, we describe some of the more important recent developments in electricity markets -- wholesale electricity spot markets and electricity "futures" contracts.[44]

Spot markets reflect the short-term price of electricity. For example, daytime spot prices are higher (due to greater energy demand) than nighttime prices. Wholesale electricity spot markets are now operating -- selling wholesale electricity at market-based rates -- at several sites in the western United States, including parts of Arizona, California, Oregon, and Washington. For spot markets to function properly, potential electricity buyers need price information on recent transactions to make informed purchasing decisions. In June 1995, Dow Jones &

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[43] Marcus, op cit., p. 24.

[44] Information was drawn from the Energy Information Administration, Department of Energy, *The Changing Structure of the Electric Power Industry -- Transitional Developments and Strategies: The Industry Prepares for Competition*, obtained from "http://www.eia.doe.gov/cneaf/electricity/chg_str/chapter9.html" on 3/17/98).

Company began meeting that need by compiling electricity price indices for western markets and publishing them in the *Wall Street Journal*.

While spot markets provide information on short-term electricity prices, electricity futures contracts reflect forecasts of long range electricity prices. Futures contracts are an arrangement calling for future delivery of a product (electricity) at an agreed-upon price. This mechanism allows traditional electric utilities and "power marketers" to hedge their risks against long-term electricity price fluctuations.[45] A set contract price is paid for power over a specified period of time, regardless of whether or not electricity prices go up or down during this period.

As competition in the electricity industry grows, and spot and futures markets expand and mature, FERC should begin using these market price indices to develop replacement power cost estimates. Market prices are more likely to reflect accurate values for a project's replacement power than estimates that rely on an assessment of construction costs for a new generation facility (i.e., FERC's "most likely thermal alternative" method). FERC would apply market prices to its analysis of gross power benefits in the same manner as replacement cost values are currently applied. For example, using the most likely thermal alternative, FERC estimated replacement power costs of about $42/MWh at the North Georgia project.[46] FERC multiplied this estimate by the average annual generation of the project (427,000 MWh) to arrive at an annual gross power benefit estimate of about $18 million. Market prices for power in the North Georgia region might be higher, lower, or the same as FERC's $42/MWh estimate. To calculate annual gross power benefits using market prices, FERC would multiply the regional market price for power by the project's average annual generation.

☞ Market information on electricity prices is becoming increasingly available. We recommend that, where possible, the economic analysis use market prices to evaluate replacement power costs.

Annual Costs Of Operation

FERC's estimate of the annual costs of operation is based on the sum of the project's annualized capital costs and current O&M costs. As described in Chapter 3, capital costs include past investment costs owed on the project ("sunk costs") and anticipated future investments costs, such as dam repair. We identified three important ways in which FERC could improve its costs of operation estimates: (1) remove "sunk costs" from the analysis; (2) estimate capital costs based on the year they are incurred; and (3) include future decommission costs in the analysis. Each of these improvements is discussed in more detail below.

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[45] Power marketers are relatively new to the electric power industry. A power marketer buys energy, transmission, and other services from traditional utilities, or other suppliers, and then resells these products. Presently, only a small number of power marketers are active in the market, but the number is expected to grow as changes in the electricity market continue.

[46] FERC, FEIS-0098, June 1996.

Remove "Sunk Costs"

> **STRANDED COSTS**
>
> During the transition from regulated electricity markets to competition, competitive prices may not provide enough revenue for some power producers to recover all the fixed costs (investments in long-lived assets) that would have been recovered under regulated pricing (as FERC has recognized in Order 888).[47] "Stranded costs" are the fixed costs incurred under regulated pricing that cannot be recovered in a competitive market. There are several reasons why power producers may have incurred these costs under regulation. First, imperfect projections of future demand caused utilities in some areas of the country to build more capacity than was actually needed. Second, the costs associated with some capacity additions, most notably nuclear capacity, increased during construction to levels above initial estimates. Third, overly optimistic expectations of future power prices led some utilities to enter into power purchase contracts at prices above the current market value. Finally, stranded costs have been exacerbated by improvements in generating technologies especially natural-gas-fired combined-cycle plants. This technology gives owners of new capacity a cost advantage over older capacity.[48]
>
> The recovery of stranded costs is the subject of significant debate. There is much disagreement about: (1) the size of the stranded costs put at risk by competition; and (2) whether stranded costs should be recoverable as part of power industry restructuring or whether large losses should be imposed on investors and taxpayers by simply ignoring stranded costs.[49]

A sunk cost is a cost that has already occurred and cannot be changed by future decisions. It should not be included in the appraisal of a project. In FERC's analysis, sunk costs are usually included as "net investment costs" -- previous expenditures that have created financial obligations for the future. For example, Georgia Power owes $36 million in net investment costs on its North Georgia project. Georgia Power will still owe this debt whether or not it decides to continue operations; the debt is not relevant to the decision. The relevant question for Georgia Power is whether *future* costs that would be incurred if the project proposal is relicensed, such as dam repair, are expected to be lower than future revenues.

On the issue of sunk costs, the public shares the applicant's perspective -- only forward-looking costs matter. From the public's point of view, FERC should be comparing the forward-looking costs of the hydropower relicensing proposals with those of the most likely alternative power source. For example, the North Georgia project's costs of operation should include the capital costs of dam repair ($25.2 million) and O&M costs going forward, but not the net investment costs ($36 million). Removing these sunk costs from the analysis would decrease the annual costs of operation from $12.8 million to roughly $7.5 million, thereby increasing annual net benefits to about $10.5 million ($18 million - $7.5 million).

It may be in an applicant's interest to include sunk costs in its costs of operation, especially if the applicant is facing the prospect of significant mitigation costs as part of relicensing. As mentioned above, including sunk costs will inflate the project's costs of operation, thereby reducing the project's overall net benefits. This provides a basis for the applicant to argue that it cannot afford mitigation costs because incurring such costs could threaten the solvency of the project.

In some cases, the practice of including sunk costs may reduce net benefits to the point where they are negative. However, applicants recognize that these projects have positive net benefits when sunk costs are left out of the financial analysis. This may be one reason why applicants have been consistently willing to continue operating projects even when FERC's analysis suggests that the projects have net negative benefits.

To make its economic analysis more useful to both society and the applicant, FERC should only examine forward-looking costs and benefits. This will be increasingly important as the electric power industry moves from a regulated environment to a competitive marketplace.[50] By excluding sunk costs from its analysis, FERC would reduce the risk that its relicensing process might create more "stranded costs" (see text box for more information on stranded costs).

☞ Only forward-looking costs are relevant to relicensing decisions. We recommend that the economic analysis exclude sunk costs (referred to as "net investment costs" in FERC's analysis).

Estimate Capital Costs Based On The Year They Will Be Incurred

Future capital costs of a project should be evaluated based on the year they are expected to be incurred by the applicant. FERC, however, appears to assume that all capital costs occur in the first year after relicensing. For example, Georgia Power expects to spend $25.2 million to make dam repairs over the 30-year period of its new license. FERC treats these costs as if Georgia Power will incur them in the first year of its license. Because of the "time value of money" (discussed in Chapter 3), FERC's assumption overstates the true costs faced by the applicant, which in turn reduces the net benefits of the project. To illustrate, if Georgia Power implemented the $25.2 million in dam repairs over the first 10 years of its new license -- at a cost of $2.7 million in the first year and $2.5 in the following nine years -- the present value of those costs would be about $17 million, roughly $8 million less than FERC's estimate.

☞ Capital investments may not all be scheduled for the first year of a new license. We recommend that the economic analysis reflect capital costs in the year in which they are expected to occur.

Include Future Decommissioning Costs

FERC should incorporate potential decommissioning or relicensing costs in its economic analysis. All hydropower projects face either decommissioning costs or relicensing costs (i.e., costs to prepare an application) with the expiration of their license. FERC does not factor these costs into its analysis and thereby underestimates the real costs of operations.[51] Moreover, FERC's approach suggests that, unlike other power generators (e.g., nuclear), hydropower project owners do not need to set aside funds for the day when their dam needs to be decommissioned. If project owners do not set aside funds, they may have an incentive to continue operating their projects even though they cannot compete, simply to avoid large decommissioning costs.

☞ We recommend that the economic analysis reflect the real costs of operation by incorporating project relicensing or decommissioning costs.

<u>Annual Benefits of Avoided Pollution</u>

Relative to alternative sources of power generation, such as coal-fired plants, hydropower production generates less air pollution. To quantify avoided pollution values, FERC estimates the tons of several air pollutants, such as sulfur and nitrogen oxides, that would be emitted if the existing project's power generation were replaced by power from an alternative source. Under FERC's approach, the dollar cost to *control* these emissions is equal to the avoided pollution benefits of the existing project.

We have identified several problems with FERC's current approach:

- **Pollution Control Costs Appear To Be Double Counted.** Pollution control costs are already captured (as part of capital and O&M expenses) in the overall cost of power for an alternative power producer (e.g., a coal-fired plant). By calculating a separate value for pollution control costs, in addition to replacement power costs, FERC is double counting. There is no need for FERC to estimate pollution control costs since they are already reflected in the alternative source's cost of power.

- **Assumptions About Existing Pollution Control Are Unrealistic.** FERC often bases pollution control cost estimates on the cost of installing control equipment for plants *without any existing pollutant removal capabilities*. FERC typically assumes that power from an existing project will be replaced by power from a coal-fired or gas turbine facility, both of which are subject to current air regulations requiring pollution control. Since existing plants already have pollution removal capabilities, FERC is probably overstating the cost of pollution control.

- **Avoided Pollution Values Are Not Incorporated In Annual Net Benefits.** FERC conducts an analysis to quantify the dollar benefits of avoided pollution, but does not include these dollar benefits in its annual net benefit calculations for relicensing alternatives.

Although these problems are notable, the most significant problem with FERC's approach is the premise that avoided pollution benefits are equal to aggregate pollution control costs. To assess the true value of avoided pollution benefits, FERC should be estimating the avoided health and environmental impacts of pollution "externalities" -- the cost to society of the pollution *not* currently controlled at the replacement source.

Estimating Pollution Damages

Estimating pollution damages requires a sophisticated model that simulates air emissions and their expected impact on human health and the environment. Several studies have been conducted to estimate the dollar per ton damages of various air pollutants.[52] In general, the results of these studies are subject to a high level of uncertainty. Damage estimates are based on many estimated parameters. In addition, damage values will tend to vary depending on the location of the power generation facility. For instance, a ton of particulate matter emitted near an urban center with smog and visibility problems, such as Los Angeles, will have higher costs than a ton of particulate matter released in a less populated, smog-free area.

To illustrate the potential per ton damages from air emissions associated with power generation, the findings from a study conducted in Minnesota are presented in Exhibit 4-6.[53] In addition to health impacts, the study examined effects on visibility, agriculture, soiling (dirtying of surfaces), and materials (damaging construction materials and corroding surfaces). These impacts were estimated based on mixes of existing and new power plants that could meet future electricity demand for hypothetical rural, metropolitan fringe, and urban location scenarios.[54]

Exhibit 4-6

DOLLAR DAMAGES PER TON OF POLLUTANT EMITTED (1993$)*

Pollutant	Rural Scenario	Metropolitan Fringe Scenario	Urban Scenario
Particulate Matter (PM)			
Health	$510 -$756	$1,793 -$2,517	$4,020 - $5,576
Soiling	$3 - $30	$13 - $121	$30 - $285
Visibility	$17 - $20	$67 - $82	$156 - $193
Total:	*$530 - $806*	*$1,873 - $2,720*	*$4,206 - $6,054*
NO_X			
Health	$7 - $24	$32 - $76	$83 - $177
NO_X with O_3			
Health	$6 - $24	$32 - $85	$83 - $210
Agriculture	$(-11) - $33	$21 - $32	$44 - $308
Total:	*$(-6) - $56*	*$53 - $118*	*$127 - $518*
SO_2			
Health	$2 - $4	$11 - $24	$21 - $40
Materials	$7 - $9	$29 - $37	$79 - $102
Agriculture	$0 - $12	$0 - $46	$0 - $42
Total:	*$9 - $24*	*$43 - $104*	*$106 - $178*

* The ranges presented in this exhibit are based on a 90 percent confidence interval. If we construct a 90 percent confidence interval, we expect the true value of the impact to be captured by this interval 90 percent of the time, based on statistical analysis.
Source: Triangle Economic Research, *Assessing Environmental Costs for Electricity Generation*, November 1994 (Revised May 1995).

While Exhibit 4-6 captures the major pollutants and potential health and environmental impacts associated with replacement electricity generation, it is important to recognize that other air emissions, such as lead and carbon monoxide, can also result in damages. In addition, power plant operations may affect water resources. For instance, cooling water withdrawal by power plants can hurt fish populations, thereby reducing commercial and recreational fishing values. These other potential damages should also be considered when evaluating the potential impacts of replacement electricity generation.

Comparing Pollution Damages To Pollution Control Costs

Assessing avoided pollution benefits based on potential health and environmental impacts, rather than by FERC's pollution control cost method, may significantly reduce avoided pollution values. To illustrate the possible differences in total costs under each approach, we apply the Minnesota study's estimates and FERC's pollution control cost estimates to an example from the North Georgia project (see Exhibit 4-7).[55] The FERC staff-recommended relicensing alternative for the North Georgia project requires the applicant to maintain minimum flows of 35 cfs year-round at the Tallulah Falls Dam, which reduces power generation by 6.7 GWh. Generating this power at an alternative source (a coal-fired plant) will result in emissions of 54.4 tons of sulfur oxides and 25.1 tons of nitrogen oxides, assuming (as FERC does) that the alternative source does not currently control any pollution. To calculate the annual removal costs, FERC simply multiplies the average per ton costs by the tons of pollutants generated.

Under the "pollution damages" approach, the per ton damages are multiplied by the tons of pollutants *released,* not the tons generated. Using FERC's assumption that pollution control equipment is capable of removing 95 percent of SO_2 and 60 percent of NO_x, we estimate that 2.7 tons of SO_2 (five percent of 54.4 tons) and 10.0 tons of NO_x (40 percent of 25.1 tons) would be emitted by an alternative power generation facility. Annual pollution damages are calculated by multiplying these emissions by the dollar per ton damage estimates from the Minnesota study.[56] As shown in Exhibit 4-7, the annual pollution damages are significantly less than the FERC's estimated annual removal costs for SO_2 and NO_x.

Exhibit 4-7

AVOIDED POLLUTION BENEFITS: A COMPARISON OF TWO APPROACHES USING AN EXAMPLE FROM THE NORTH GEORGIA PROJECT

		"Cost Of Pollution Control" Approach		"Damages To Human Health & Environment" Approach	
Pollutants	**Pollutants Generated (tons/year)**	**Average Per Ton Cost ($) To Control Pollutants***	**Annual Removal Cost (SO_2 95% removed, NO_x 60% removed)**	**Per Ton Damages ($) To Human Health & Environment****	**Annual Damages (from 5% SO_2 emissions and 40% NO_x emissions)**
Sulfur Oxides	54.4	$475	$25,800	$42-$104	$100-$300
Nitrogen Oxides	25.1	$230	$5,800	$53-$118	$500-$1,200
Total Costs			**$31,600**		**$600-$1,500**
Cost Per GWh***			**$5,000**		**$100-$250**

* These estimates are based on "state-of-the-art" pollution control equipment capable of removing 95 percent of sulfur oxides and 60 percent of nitrogen oxides. The cost estimates are for plants without any current pollution removal capabilities. FERC's per ton costs represent *average* control costs, not the *marginal* cost of controlling an additional ton of pollutants.
** Per ton damages are based on estimates from the Minnesota study's "metropolitan fringe scenario," see Exhibit 4-6.
*** This analysis was based on the emissions that would result from 6.7 GWh of replacement power.
Sources: FERC, *Final Environmental Impact Statement, North Georgia Hydroelectric Project*, FEIS-0098, June 1996; Triangle Economic Research, *Assessing Environmental Costs for Electricity Generation*, November 1994 (Revised May 1995); IEc analysis.

Using annual damage estimates to calculate avoided pollution benefits may reduce the avoided pollution costs of replacement power, thereby reducing the net benefits of the project under consideration. In Exhibit 4-7, the avoided pollution benefits of generating a GWh of power at a hydropower project, rather than an alternative source, appear to be only about $100-$250 -- about five percent of the costs estimated by FERC. While damages may be higher for other cases (e.g., where additional pollutants cause damage), basing avoided pollution benefits on damage estimates rather than FERC's pollution control cost estimates will generally result in reduced avoided pollution benefits.

☞ As a more defensible basis for estimating avoided pollution benefits, we recommend that the economic analysis estimate the benefits of avoiding health and environmental impacts from pollution *not* controlled, rather than estimate average pollution control costs.

SUMMARY

FERC's current economic methodology may bias relicensing decisions against alternatives that include environmental measures. We discuss how incorporating non-power values into net benefit estimates would reduce this bias; this establishes the basis for a more complete examination of the analytic methods available for estimating non-power values in Chapters 5 and 6. In addition, we recommend several other changes to FERC's economic approach, including refinements to FERC's assumed discount rate and baseline for analysis and a new approach for estimating avoided pollution benefits.

We also identify several potential problems with FERC's current approach to estimating gross power benefits and the costs of operation. Although these problems do not bias FERC's analysis in any systematic way, refinements to FERC's approach could improve the accuracy of net benefit estimates.

Exhibit 4-8 summarizes our recommended refinements and notes their implications for net benefit estimates. Collectively, these recommendations are intended to improve the quality of FERC's net benefit estimates and expand the usefulness of FERC's economic analysis in relicensing decisions.

Exhibit 4-8 SUMMARY OF RECOMMENDED REFINEMENTS TO HYDROPOWER RELICENSING ECONOMIC METHODOLOGY			
Component In Current Economic Methodology	**Problem With Current Analysis**	**Recommendations**	**Implications of Recommendations**
Benefits of Environmental Measures	**Environmental benefits** not quantified or included in net benefit estimates.	Estimate environmental benefits and include them in net benefit calculations.	Increases the net benefits of alternatives calling for environmental measures.
Basic Assumptions	**Discount rate** of ten percent is too high.	Use a lower discount rate. Based on discount rates applied by other federal agencies, two percent (lower bound) and seven percent (upper bound) may be appropriate.	Increases the value of benefits that occur further into the future (e.g., the recovery of an ecosystem).
	Baseline for analysis does not account for "without the project" conditions.	Use information on what conditions would be like without the project as a reference point to identify potential non-power benefits associated with the river resource.	Ensures that the potential public benefits of river restoration receive due consideration.
Gross Power Benefits	**Energy demand** may be overstated.	Use independent sources (rather than applicant estimates) to assess the region's energy demand and the need to replace power that may be lost due to decommissioning or new licensing conditions.	Reduces potential bias in energy demand projections.
	Fuels costs may be overstated; **heat rates** may be understated.	Fuel costs can change rapidly; update fuel cost data regularly. Assume higher (less efficient) heats rates for new generation facilities, in the range of 6,500-7,500 BTU/kWh.	Improves accuracy of gross power benefit estimates.
	Length of plant life may be understated.	Assume a longer plant life -- perhaps 30 years -- for new replacement generation facilities.	Reduces replacement costs, thereby reducing gross power benefits, and project net benefit.
	Least cost thermal alternative approach is less accurate than using market price information.	Market information on electricity prices is becoming increasingly available. Where possible, use market prices to evaluate replacement power costs.	Improves accuracy of gross power benefit estimates.
Costs of Operation	**Sunk costs** are improperly included.	Only forward-looking costs are relevant to relicensing decisions. Remove sunk costs (referred to as "net investment costs" in FERC's analysis) from the economic analysis.	Reduces the costs of operation, increasing project net benefit.
	Timing of capital costs is assumed to be the first year of a new license.	Capital investments may not all be scheduled for the first year of a new license. Capital costs should reflect the year in which they are expected to occur.	Reduces the costs of operation, increasing project net benefit.
	Future costs to relicense or decommission are not included.	Reflect the real costs of operation by incorporating project relicensing or decommissioning costs in the economic analysis.	Increases the costs of operation, decreasing project net benefit
Avoided Pollution Benefits	**Avoided pollution benefits** based on pollution control costs rather than impacts of pollution *not* controlled.	Base benefits on avoided health and environmental impacts of pollution released.	May reduce avoided pollution benefits. Provides a more defensible basis for estimating avoided pollution benefits.