DISCOUNTING FUTURE FUEL COSTS AT A SOCIAL DISCOUNT RATE

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ABSTRACT

This staff paper responds to the 2008 IEPR Update Committee's May 15, 2008, scoping order directing Energy Commission staff to identify the consequences of using a social discount rate to discount future fuel costs, and provides background for the discussion on discount rates to be held during the workshop on procurement issues to be held August 18, 2008. It briefly reviews the rationale for discounting; summarizes how three agencies (the White House Office of Management and Budget, California Energy Commission, and California Public Utilities Commission) have considered the question of selecting discount rates for various purposes; describes how discount rates can be based on either private or public (social) costs of capital; and discusses how the consideration of risk or uncertainty associated with future cash flows may affect the selection of a discount rate. The paper also illustrates cost impacts by presenting sample calculations showing the relative effects of high and low discount rates on the fuel and generating costs of a hypothetical natural gas-fueled combined-cycle power plant. The report's final section summarizes staff's observations on the positions put forth in the literature concerning the use of risk-adjusted discount rates, and poses several questions regarding their use in electricity planning and procurement activities.

Key Words: discount rate, social discount rate, private discount rate, risk-adjusted discount rate, fuel risk, utility planning

Introduction and Summary

The *2007 Integrated Energy Policy Report* (IEPR) states that "(California investor-owned utilities' long-term procurement plans) apply inappropriately high discount rates to future fuel costs, thereby understating the impact upon consumers. The net result is a systematic undervaluing of non-fuel-intensive procurement alternatives, such as efficiency and renewables, and an increasing dependence on gas-fired generation."[1] The *IEPR* then recommends that long-term procurement plans should "discount future fuel costs at the three percent social discount rate used in standard-setting activities, unless the investor-owned utilities can demonstrate that these costs should be assigned to shareholders."[2] Accordingly, the 2008 IEPR Update Committee's May 15, 2008 scoping order directs the staff to identify the consequences of using a social discount rate.

The *IEPR*'s goal is to provide the best value to California's electricity consumers by correctly incorporating the riskiness of gas-fired generation when comparing it to generation using different fuels or non-fuel alternatives, such as renewables or efficiency. The *2007 IEPR* expressed concern that current economic methods excessively discount future natural gas fuel costs, making those costs appear unrealistically inexpensive. This results in an overdependence on natural gas-based generation and undervaluing of alternatives, such as renewables. Applying a 3 percent social discount rate to future natural gas costs (lower than the current discount rate that is based on the utility's cost of capital) would raise, and thus more accurately reflect, the apparent costs of natural gas-based generation. This staff paper discusses discount rates, provides an overview of opinions regarding their use, identifies consequences of applying a social discount rate to natural gas fuel costs, and poses questions related to incorporating discount rates into long-term planning to account for risk. Its purpose is to provide background for the discussion on discount rates to be held during the 2008 IEPR Update Committee workshop on procurement issues to be held August 18.

The first section, Discount Rates and Discounting, briefly reviews the rationale for discounting.

The next section, Use of Discount Rates at Selected Government Agencies, summarizes how three agencies (the White House Office of Management and Budget, California Energy Commission, and California Public Utilities Commission) have considered the question of selecting discount rates for various purposes. It also describes how discount rates can be based on either private or public (social) costs of capital. To simplify the discussion, this section assumes that no risk is associated with the cash flows and that they are known with certainty (that is, the cash flows are neither higher nor lower than anticipated).

The third section, Adjusting Discount Rates for Risk, discusses how the consideration of risk or uncertainty associated with future cash flows may affect the selection of a discount rate. Traditional financial analysis takes the investor's point of view and may call for the use of risk-

[1] California Energy Commission, *2007 Integrated Energy Policy Report,* CEC-100-2007-008-CMF, 64.

[2] Ibid.

adjusted discount rates based on the market value of the particular project in question. Decision (or portfolio) analysis includes broader perspectives compared to financial analysis and risk may be incorporated in other ways than through discount rate adjustments.

The fourth section, Consequences of Using a Social Discount Rate on the Levelized Costs and Present Value of a Combined-Cycle Plant, illustrates cost impacts by presenting sample calculations showing the relative effects of high and low discount rates on the fuel and generating costs of a hypothetical natural gas-fueled combined-cycle power plant. Two discount rates, representing a private cost of capital and a “social” discount rate, illustrate the differences on levelized costs and present values. Discount rates affect present values more than levelized costs.

The report’s final section summarizes staff’s observations on the positions put forth in the literature concerning the use of risk-adjusted discount rates. It also poses several questions regarding their use in electricity planning and procurement activities.

Discount Rates and Discounting

Money held today will be worth more in the future because it may be invested to generate earnings during the intervening period. Thus, at an interest rate of 5 percent, $100 at the present time will be worth $105 one year from now. Conversely, at the same interest rate, the value of $105 in the future is equivalent to $100 now. In this case, the $100 may be referred to as the present value of the $105 discounted at 5 percent. Discounting is used to reflect the value that investors, including society, put today on money that will be available in the future. The greater the discount rate, the more investors value money today versus money tomorrow.

In addition to the positive return that an invested resource will earn, there are two additional rationales for discounting future values:

- Postponed benefits also have a cost because people generally prefer present to future consumption. They are said to have positive time preference.
- If consumption continues to increase over time, as it has for most of U.S. history, an increment of consumption will be less valuable in the future than it would be today.

Whereas interest rates are determined exogenously (rates paid by various banks, bonds, commercial paper, and so forth), the discount rate is chosen by the analyst. Since not investing means forgoing the income that could be earned in the meantime and incurring a cost in the form of a lost opportunity (opportunity cost), the discount rate to determine the present value of a project is frequently the return that would otherwise be earned on the funds that would be used for the project. If the net present value of all costs and benefits of a project is negative, then the return realized by the alternative use for those funds would be superior, and the proposed project should not be undertaken.

In general, higher discount rates, such as those generally derived from the cost of capital or market costs in the private sector, favor projects with lower initial costs and higher future costs, since future costs are discounted more heavily relative to costs incurred nearer to the present. Thus, future generations may bear a disproportionate share of project costs if those costs are delayed. Lower discount rates, such as those associated with the public sector cost of capital, increase the present net worth of projects with early costs and later benefits.

Use of Discount Rates at Selected Government Agencies

A private corporation analyzing a project often uses the firm's weighted average cost of capital (WACC) or the weighted average cost of the debt and equity (common and preferred stock) as a discount rate. Discount rates used by government agencies may also be based on the private cost of capital if, for example, the main effect of a regulation would be to displace or alter the use of capital in the private sector.

For example, in providing discount rate guidance to federal agencies, the White House Office of Management and Budget (OMB) stated that for their base-cases analyses, federal agencies should use a discount rate that approximates the marginal pretax rate of return on the average private sector investment:

> In general, public investments and regulations displace both private investment and consumption. To account for this displacement and to promote efficient investment and regulatory policies, the following guidance should be observed.
>
> Base-Case Analysis. Constant-dollar (excludes inflation) benefit-cost analyses of proposed investments and regulations should report net present value and other outcomes determined using a real (staff note - excludes inflation) 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. [3]

The 7 percent rate approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector.[4]

The Energy Commission has also used discount rates based on the private cost of capital. The Energy Commission staff report *Update of Appliance Efficiency Regulations* examined cost and performance evaluations for then-proposed appliance efficiency standards using present value and payback calculations.[5] Staff derived a discount rate based on the real after-tax cost of capital for building owners or purchasers of commercial equipment, on the basis that major purchases can be funded through financing with tax deductible interest.[6] Staff examined a variety of

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[3] White House Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, Circular No. A-94, October 29, 1992, section 8.b.1.

[4] Ibid., 33.

[5] California Energy Commission, *Update of Appliance Efficiency Regulations*, CEC-400-04-007F.

[6] Ibid., 50.

interest rates, including a 30-year fixed rate home loan, $10,000 home equity loan, credit union 7- and 20-year fixed home equity loans, and a credit union Visa platinum credit card.[7] The average of the interest rates was determined to be 2.77 percent. Staff concluded that a real after-tax rate of 3 percent was plausible for reasonable combinations of assumptions, since higher interest rates would be correlated with higher inflation rates.[8]

For long-lived government projects that benefit the public good, some advocate the use of a "social" discount rate that more closely reflects the cost to the government of using those funds. One argument favoring the use of lower social discount rates when applied to public projects is that market rates are too high in the context of future generations' interests. Market discount rates arise from the behavior of individuals, but the state is a separate entity with the responsibility of guarding collective welfare and the welfare of future generations as well. Thus, the rate of discount relevant to state investments will not be the same as the market discount rate and, since high rates discriminate against future generations, the state discount rate should be lower than the market discount rate.[9] This idea may be extended by some to include not only government projects, but also private projects that serve the public good and that have some of the attributes of government projects, that is they are long-lived and funded by the public (such as transmission lines).

The use of social discount rates may also be considered as a remedial measure to counteract market externalities or inefficiencies. For example, there is abundant evidence that cost-effective energy efficiency improvements are obstructed by market imperfections, including distorted energy prices and a gap between the discount rates used by private households and businesses and the discount rates used in investment decisions by regulated utilities. Customers demand sharply higher annual rates of return, which differ sharply from those of investors in electric generation. This imbalance results in relatively low-return investments in generation that could have been displaced cost-effectively with energy efficiency.

After its determination in 1992 that federal agencies should use a discount rate of 7 percent, the Office of Management and Budget revisited the subject in 2003. At that time, it concluded that a social discount rate may also be justified when a regulation affects private consumption rather than private investment or capital:

> The effects of regulation do not always fall exclusively or primarily on the allocation of capital. When regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower discount rate is appropriate. The alternative most often used is sometimes called the "social rate of time preference." This simply means the rate at which "society" discounts future

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[7] Ibid., 51-52.

[8] Ibid., 52.

[9] David W. Pearce and R. Kerry Turner, *Economics of Natural Resources and the Environment* (Baltimore: Johns Hopkins University Press, 1990), 222-223.

> consumption flows to their present value. If we take the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around 3 percent in real terms on a pre-tax basis.[10]

OMB recommended that for regulatory analysis, both 3 and 7 percent (real) discount rates be used.[11]

The Energy Commission consultant report *Economic Evaluation of Transmission Interconnection in a Restructured Market* (CEC-700-04-007) by the Consortium of Electric Reliability Technology Solutions (CERTS) reviewed the California Independent System Operator's (California ISO) development of a comprehensive method for economic evaluation of transmission projects in the restructured wholesale electricity market.[12] The report posed the question "Should we continue to use the rate of return specified by the California Public Utilities Commission (CPUC) for a Transmission Owner as the discount rate in the restructured wholesale market?"

CERTS determined that high voltage transmission in a restructured electricity market has become a public good since the benefit from a project cannot be denied to any retail customer or generation owners and the cost is shared by every customer. CERTS concluded that:

> For calculating the present worth of a "public good" project, one should use the "social rate of discount" instead of the "opportunity cost of capital."[13]

and

> We should accept the fact that high voltage transmission system has also become a "public good" in the restructured market. As with other public goods, the social discount rate should be used to calculate the present worth of benefits from a new transmission upgrade or expansion.[14]

Thus, CERTS recommended that in the California ISO model:

> The social discount rate should be used in determining the present worth of these benefits. The social discount rate is a function of per capita real consumption growth and the elasticity of the marginal utility of consumption. The social discount rate is

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[10] White House Office of Management and Budget, *Regulatory Analysis*, Circular No. A-4, September 17, 2003, 33.

[11] Ibid., 34.

[12] Consortium of Electric Reliability Technology Solutions, *Economic Evaluation of Transmission Interconnection in a Restructured Market*, prepared for the California Energy Commission, June 2004, CEC-700-04-007.

[13] Ibid., 28.

[14] Ibid., 29.

> around 5 percent for the U.S., which is much less than authorized rate of return for utilities.[15]

The Energy Commission staff draft white paper *Upgrading California's Electric Transmission System: Issues and Actions for 2004 and Beyond* (CEC-100-04-004D) was prepared in Support of the 2004 Integrated Energy Policy Report Update Proceeding (03-IEP-01) and based in part on the above CERTS report produced for the Energy Commission.

Energy Commission staff determined that high voltage transmission infrastructure in a restructured market has increasingly become a public good, in that project benefits cannot be denied to any retail customer or generation owner, the cost is shared by every customer, the planning activity is shared between the utility and the California ISO, the utility does not control the operation of the high voltage transmission lines, the utility's customers do not receive all the benefits of a transmission line constructed by the utility, and the capital cost of a new project is paid through the Transmission Access Charge by all retail customers in the California ISO grid.[16] Staff concluded:

> Consistent with this view, the staff believes that state decision makers should apply the "social rate of discount" when using the "societal test" to make a decision on the economic value of a project.[17]

Another example comes from the August 23, 2004, IEPR Update Committee Workshop on Upgrading California's Transmission System. Staff posed the following question to participants: Is the use of a social discount rate an appropriate method when evaluating transmission system additions to reflect the long useful life (30 to 50 years) and public goods nature of transmission investments? Testimonies of the Los Angeles Department of Water and Power (LADWP) and The Utility Reform Network (TURN) represent two points of view.

In its testimony, LADWP supported the concept of using a social discount rate in assessing the benefit of transmission projects for those projects that can be deemed desirable for the "public good," but stated that the use of the method offered by CERTS developed by economists to define this rate is unnecessary and may be subject to either intended or unintended manipulations and errors. The state already has access to a social discount rate that is well defined and documented in the long-term bond markets. These rates used by the state in borrowing money for public projects can and should be used since these monies are prioritized and dedicated for the public good.[18]

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[15] Ibid., 34.

[16] California Energy Commission, *Upgrading California's Electric Transmission System: Issues and Actions for 2004 and Beyond*, Draft Staff Paper, July 2004, CEC-100-04-002D, 21-22.

[17] Ibid., 22.

[18] Los Angeles Department of Water and Power, *Comments of the Los Angeles Department of Water and Power on Topics Discussed at the August 23, 2004, Upgrading California's Transmission System: Issues and Actions for 2004 and Beyond Workshop*, September 7, 2004, 2.

The Utility Reform Network (TURN) testified that many of the reasons cited to justify a social discount rate were already incorporated in other venues, so that adjusting the discount rate would essentially be double counting those factors. It would thus be preferable to incorporate the strategic benefits of transmission listed in the staff paper directly into the benefit/cost method, rather than change the discount rate:

- Since the California ISO has already undertaken an extensive estimate of market power mitigation in its proposed Transmission Economic Assessment Methodology, using a social discount rate to incorporate this benefit would mean double-counting this factor.[19]
- Achieving state policy objectives for renewables is already being incorporated into transmission planning by implementing a higher priority for construction of transmission for renewable generation. Using the rationale that transmission supports renewables as a justification for a low social discount rate is double-counting this benefit.[20]
- Ratepayers are already paying for insurance against resource inadequacy and high prices through reserve margin requirements, demand response goals, and so forth. Any insurance benefit that is to be attributed to transmission should be calculated as incremental to the insurance that is already available from implementation of the above steps. Insurance benefits should not be double-counted.[21]

Additionally, TURN testified that the cost-effectiveness of different utility investments, such as energy efficiency vs. transmission, is ultimately weighed at the CPUC where limited capital resources are rightfully judged using the utility's cost of capital. Thus, a project under an Energy Commission analysis that might be cost-effective using a social discount rate may still prove non-cost-effective at the CPUC. It is therefore important that the same discount rate be used in these tradeoffs to properly allocate limited capital resources.[22]

In the *2004 IEPR Update*, the Energy Commission made the following recommendation:

> The Energy Commission recommends using a social discount rate, comparable to that used for its buildings and appliance standards, for evaluating the costs and benefits of transmission investments in a properly focused state transmission planning process.[23]

The California Public Utilities Commission conducted an *Investigation into the Methodology for Economic Assessment of Transmission Projects* (I.05-06-041) concurrently with Southern California Edison's application for a Certificate of Public Convenience and Necessity concerning the Devers-Palo Verde No. 2 Transmission Line Project. The October 28, 2005, scoping order (p. 6)

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[19] The Utility Reform Network, *Comments of the Utility Reform Network on Draft Staff White Paper on Transmission Issues*, September 2, 2004, 2.

[20] Ibid., 2-3.

[21] Ibid., 4.

[22] Ibid., 6-7.

[23] California Energy Commission, *Integrated Energy Policy Report 2004 Update*, November 2004, CEC-100-04-006CM, 31.

asked parties to comment on the appropriateness of using a social discount rate versus the utility cost of capital and, if the Commission uses a social discount rate in analyzing DPV2 or other transmission lines, what that discount rate should be.

In the CPUC's investigation, Southern California Edison testified that the concept of a social discount rate is difficult to measure, claimed values can vary widely, the use of social discount rates in project evaluations is inappropriate, does not reflect the cost of raising capital, and will distort economics and yield higher customer costs.[24]

The CPUC's November 9, 2006, Decision in that investigation concluded that:

> Consistent with our determination in D.05-04-051, the applicant's weighted cost of capital, as adopted most recently by the Commission, should be used as the discount rate in evaluating the benefits of a transmission project. Consistent use of the utilities' weighted cost of capital as a discount rate will facilitate our comparison of proposed transmission projects and alternative investments.[25]

In summary, this section has shown that agencies use different discount rates for various purposes. Discount rates may be based on either the private cost of capital or the cost to the government of using funds (public or social cost of capital). The discount rate chosen may depend on the type of project to be undertaken or the effect of the particular regulation in question. Projects that benefit the public good and are long-lived (even if proposed by a private firm) may be analyzed using social discount rates, which reflect the government's lower cost of capital relative to the private sector. Agencies may also use discount rates based on the private cost of capital to assess regulations that affect the use of capital in the private sector.

Adjusting Discount Rates for Risk

The previous sections discussed discounting in the context of cash flows that are known with certainty (that is, cash flows that will be neither higher nor lower than anticipated). This section discusses the choice of discount rates when future cash flows are uncertain and therefore subject to varying degrees of risk. In this section, the term "risk-adjusted" refers to specifically changing a discount rate in order to reflect perceived risk or using a social discount rate (which is lower than a private discount rate) to reflect the higher risk of future expenses, such as natural gas costs.

Based on the variety of opinions discussed below, views on the subject of discounting under uncertainty at first glance generally seem to fall into one of two camps. One is that discount

[24] Southern California Edison, Devers-Palo Verde No. 2 Transmission Line Project – *Applicant's Supplemental Prepared Direct Testimony before the Public Utilities Commission of the State of California, Application no.: 05-04-015 & I.05-06-041, Exhibit no.: SCE-2, Testimony of Paul T. Hunt, Jr.*, November 22, 2005, 4.

[25] D. 06-11-018, 37.

rates should not be affected by the uncertain nature of the future cash flows and should continue to be based on the cost of capital, or the return that would otherwise be earned on the funds to be used for the project (opportunity costs). An alternative view is that discount rates should be adjusted for risk to reflect the uncertainty of the cash flows in question, so that based on the market values of those cash flows, high-risk returns should be discounted at higher rates and high-risk costs should be discounted at lower rates. In the latter instance, for example, potentially very high fossil fuel costs that could occur in the distant future would still figure prominently in current planning efforts, as their present worth would not be overly devalued by excessively high discounting.

The Electric Power Research Institute (EPRI) discussed differences between two methods that corporations, including utilities, use to analyze the desirability of projects.[26] A review of EPRI's comparison of the two analytical methods provides some useful insights into the issue of adjusting discount rates for risk. EPRI explained that the two analytical methods have differences in perspective from which risks are evaluated, thus appearing to give different answers to the same question. Finance theory analyzes the investor's perspective, or the market value of investments. Decision analysis uses the perspective of the corporate decision maker and may include considerations of project specific risks that are internal to the company as well as the risks and benefits to stockholders, employees, and customers.

Financial analysis is primarily descriptive, attempting to describe the structure of capital markets and estimate the market values of an investment. It often uses a discount rate that is adjusted for risk and applies this rate to a single expected cash flow. The risk premium depends on the risk of the specific cash flow that is being discounted and is derived from capital market data. Finance methodology focuses only on the risks that investors require compensation to bear.

In contrast, decision analysis is primarily prescriptive, providing decision makers with a method for choosing among a set of alternatives with uncertain outcomes. It lays out uncertain cash flow scenarios and evaluates each using a risk-free (unadjusted) discount rate. Decision analysis evaluates the decision maker's preferences (represented by utility functions) among uncertain outcomes. The utility function is valued by the certainty equivalent, which is the amount of cash today that will provide the expected utility of the uncertain future cash flow and represents the risk-adjusted value of the cash flow. Along with the market value of the investment, the corporate decision maker's perspective may include additional concerns, such as technical risks of the project and long-term stability. Decision analysis applications include all risks that the decision maker perceives, including those that investors can avoid. Thus, the choice between adjusting a discount rate for risk and using an unadjusted rate seems to be predicated on the type of analysis being performed.

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[26] Electric Power Research Institute, *Evaluating the Effects of Time and Risk on Investment Choices: A Comparison of Finance Theory and Decision Analysis*, prepared by Applied Decision Analysis and Charles River Associates Incorporated, EPRI P-5028, January 1987.

Awerbuch proposes using risk-adjusted discount rates for utility planning purposes. He argues that the widespread use of the utility WACC as the discount rate for project alternatives is inconsistent with textbook finance, leading to distorted results and sub-optimal decisions.[27] In utility resource planning, initial and annual operating costs of different resource options are compared using the revenue-requirements method (RRM), a project-evaluation technique that discounts future costs (that is, revenue requirements) into present values. The WACC is the investor's discount rate used to project the firm's net cash flows and reflects operating risks coupled with financing risks. As such, Awerbuch considered that applying it to the revenue requirements of a particular project is incorrect because:

- It is an average, obscuring risk differences among resource options;
- While the RRM examines only the costs (or outflows), the WACC reflects the risk of the net cash flows. The WACC reflects the overall net cash-flow risk faced by investors who generally do not care about cash inflow and outflow components. Ratepayers, on the other hand, who see only the project's outflows, are faced with a much riskier proposition, so it does not make sense to discount their cash profile at the investors' discount rate.

According to Awerbuch, risky fuel expenses are discounted too heavily using the WACC, masking their importance and overstating their desirability relative to less risky capital outlays. This is particularly important for comparisons involving relatively low risk renewable technologies that have virtually no annual cash outflows. Properly analyzed, risky fuel outlays should reduce the project's desirability by raising the present value of its fuel-related revenue requirements. Capital market theory therefore suggests that fuel outlays be discounted at lower rates.

In *Capital Budgeting for Utilities: The Revenue Requirements Method*, EPRI takes the same position as Awerbuch concerning the use of the utility WACC and also discusses the use of certainty equivalents in place of risk-adjusted discount rates.[28]

EPRI observes that the cost of capital for the corporation is often used as a risk-adjusted discount rate. However, the risk premium for the corporation may not be equal to the risk premium for any particular project in the portfolio and may have no relation to the risk of a project that is not part of the existing portfolio. The relevant cost of capital is specific to the project, not the corporation.[29] The risk-adjusted discount rates used to calculate the present value of revenue requirements should be selected in light of the cost characteristics of the investment, rather than the profit characteristics. The risk-adjusted discount rates used to calculate the present value of revenue requirements are derived from interest rates and risk premiums observed in the capital markets. However, this is not a rigorous valuation procedure,

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[27] Shimon Awerbuch, "The Surprising Role of Risk in Utility Integrated Resource Planning," *The Electricity Journal*, April 1993.

[28] Electric Power Research Institute, *Capital Budgeting for Utilities: The Revenue Requirements Method*, prepared by Charles River Associated Incorporated, EPRI EA-4879, October 1986.

[29] Ibid., 2-2.

as each component of the cost of capital can change from period to period: changes in supply and demand drive the real interest rate; changes in inflation expectations drive the inflation premium, and risk characteristics may change over the project lifecycle.[30]

Alternatively, EPRI notes, risk may be formally incorporated by discounting certainty-equivalents to the present using a discount rate that reflects the value of time only. A rigorous valuation procedure would recognize each component of the cost of capital in separate steps rather than collapsing them into a single discount rate. The discount rate would reflect the value of time only and risk would be treated by replacing expected cash flows with certainty equivalents determined on the basis of cash flow risk in each period.[31]

On June 4, 2007, Energy Commission staff held an IEPR Staff Workshop on the subject of Portfolio Analysis and posed the following question to participants: Should different discount rates be used to evaluate cost streams with different volatilities/levels of uncertainty (that is, use of a lower rate for riskier cost streams)?

C.K. Woo's response to staff's question, including an explanation of the use of certainty equivalents,[32] is summarized in the following paragraphs.

The cost stream of a portfolio of energy resources is the aggregate of the underlying component-specific streams. The accepted practice is to use a single discount rate, regardless of whether one component's cost stream is more or less uncertain than another one. If a component of the portfolio's overall cash flow is highly uncertain, that uncertainty drives the portfolio's cost risk. All present value calculations should be performed with a single discount rate. Ironically, if differential uncertainties were to be internalized via varying discount rates, a portfolio with many uncertain cost streams would not have a cost variance, as all of the uncertainties would have been resolved by the varying discount rates.

Woo offered the following example (paraphrased here by staff) using three cases involving a decision maker to illustrate that the discount rate should remain constant in present value calculations involving uncertainty:

- Case 1 (computation under certainty): Suppose the decision maker faces a payoff of $110 that will occur next year with certainty. To convert this future payoff into today's dollars, the decision-maker discounts the future sum over one year (assuming a 10 percent discount rate) to compute a present value of $100.
- Case 2 (computation under uncertainty by a risk-neutral decision maker): Suppose that next year's payoff is uncertain, and that it could be either $55 or $165, each with a probability of 50 percent. In this case, the expected value of the payoff is simply the sum of the probabilities of each of the possible payoffs, or (0.5 x $55) + (0.5 x $165) = $110. If the

[30] Ibid., 4-8.

[31] Ibid., 4-9.

[32] C.K. Woo, *Comments submitted for June 4, 2007, Staff Workshop on the Use of Portfolio Analysis in Electric Utility Resource Planning*, June 1, 2007.

decision maker is risk-neutral and only cares about the size of expected payoff, his/her present value of the expected payoff of $110 is identical to Case 1 above (that is, discounting the expected value of $110 over one year (assuming a 10 percent discount rate) to compute a present value of $100). The presence of uncertainty does not change the risk-neutral decision maker's use of a single market (discount) rate to make the present value computation.

- Case 3 (computation under uncertainty by a risk-averse decision maker): In considering the two cases presented above, a risk-averse decision maker would not be indifferent between them, due to the possibility of a lower payoff in Case 2. Thus, he would value the Case 2 option lower than Case 1 and would be willing to accept a certain value instead of the Case 2 option with its potential for a lower payoff. That certain value is referred to as the certainty equivalent of the expected value. The risk-averse decision maker then becomes indifferent between that (lower) certain value and the (higher) expected value of the uncertain payoffs. The risk-averse decision maker computes the present value of the uncertain payoff using the certainty equivalent rather than the expected value as in Case 2. The appropriate discount rate is still the market rate applicable to the decision maker.

Thus, Woo concludes that using varying discount rates to internalize and resolve differential uncertainties defeats the purpose of a portfolio analysis, which is to find an efficient frontier that summarizes the tradeoff between the portfolio's cost expectation and cost risk.

Analytical Difficulties of Adjusting Discount Rates for Risk

Several authors have identified conceptual problems associated with using risk-adjusted discount rates to account for uncertainty in future cash flows. The primary difficulty is in correctly determining the degree to which discount rates should be adjusted to properly reflect risk. The preferred approach is to separate the question of risk and discount rates.

Woo[33] cited the following reasons that applying a low discount rate to a more uncertain cost stream, to enlarge the stream's present value, is faulty:

- It is not supported by how one would derive the certainty equivalent of the expected value of uncertain costs. As the size of the certainty equivalent critically depends on the decision-maker's risk aversion that no one really knows, its computation can easily be arbitrary.

- It has not been shown that there is an economically meaningful relationship among the expected value of uncertain costs, the certainty equivalent of expected costs, and the discount rate. Absent this relationship, the use of a low discount rate to reflect uncertain costs is arbitrary.

- If one has already increased the expected value of uncertain costs by reason of risk-aversion and the related concept of certainty equivalent, applying a low discount rate is numerically double-counting.

[33] Ibid.

Stokey and Zeckhauser assert that adjusting the discount rate to compensate for risk is widely agreed to be not only incorrect conceptually, but also likely to result in significantly inferior choices:

> Raising the discount rate in effect changes the tradeoff rate between payoffs in different periods, yet there is no inherent reason why uncertainties about the amounts of future payoffs should affect the way we are willing to trade off one year's payoff against the following year's. The correct analytical approach is to separate the question of risk-free discount rate from the question of how we value risky outcomes.[34]

Everett and Schwab point out that the relationship between risk and discount rates is not linear.[35] Typically, the risk premium in a risk-adjusted discount rates is assumed to be proportional to the variance or standard deviation of the particular cash flow. Such a view represents a gross oversimplification in their view, since the variance of cash flows alone is not an adequate measure of risk. The risk-adjusted discount rate will depend not only on the perceived variation of a given cash flow, but also on the cash flow's expected value. Risk-adjusted discount rates will not be a linear function of risk, even within a single period. They conclude that for high degrees of risk, one should resort to other techniques, such as certainty equivalents.[36]

Similarly, Pearce and Turner state that uncertainty about the presence or sale of benefits and costs may be unrelated to time, and certainly appears unlikely to be related in such a way that the scale of risk obeys an exponential function as is implied in the use of a single rate in the discount factor.[37] It is not that uncertainty and risk are irrelevant to the decision-guiding rule, but their presence should not be handled by adjustments to the discount rate, for such adjustments imply a particular behavior for the risk premium which is hard to justify.[38]

Including Risk in the Decision Making Process

Rather than adjusting discount rates, several authors advocate integrating risk considerations into the decision-making process, but also caution against redundancy. Staff suspects that these discussions pertain more to higher level planning and policy considerations. As noted earlier, strict project-versus-project comparisons in the context of capital budgeting using cash flow analysis may indeed use risk-adjusted discount rates within the principles of finance theory. Several parties question the wisdom of doing so when other measures that account for risk are used simultaneously.

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[34] E. Stokey and R. Zeckhauser, *A Primer for Policy Analysis* (New York: Norton, 1978), 173.

[35] James Everett and Bernhard Schwab, "On the Proper Adjustment for Risk Through Discount Rates In a Mean-Variance Framework," *Financial Management*, Summer 1979, 61-62.

[36] Ibid., 64-65.

[37] Pearce and Turner, *Economics of Natural Resources and the Environment*, 218-219.

[38] Ibid.

Stokey and Zeckhauser recognize that the needs of future generations, who are represented in the marketplace only by their predecessors, should not be ignored, particularly when it comes to the exhaustion of valuable natural resources or the irreversible destruction of all kinds of amenities, from scenic vistas to the ozone layer. But the way to handle these issues analytically is to identify probabilities where appropriate, not to resort to a second-best juggling of the discount rate.[39]

In *Principles of Engineering Economics*, Grant et al. caution that in the process of analysis and decision making, uncertainties should not be considered at a number of different stages: do not shorten estimated lives, then shade estimates of cash flow by disbursements, then require an extremely high minimum attractive rate of return because of risk, and then also give weight to the risk at the final step of making the decision.[40]

Pearce and Turner note that the implication that discount rates should be lowered, at least when decisions are thought to involve environmental effects in a significant way, could be counter-productive. An alternative to integrating environmental concerns into decision-making would thus be desirable.[41]

Nordhaus considers ad hoc manipulation of a discount rate to achieve long-term goals to be a very poor substitute for policies that focus directly on the ultimate objective. In general, targeted approaches will be more efficient ways of accomplishing long-term environmental or social objectives. The best approach will generally be to identify the long-term objectives and to take specific steps to override market decisions or conventional benefit-cost tests so as to achieve these long-term goals.[42]

The Office of Management and Budget recommends that because such uncertainty is basic to many analyses, its effects should be analyzed and reported. Analyses should attempt to characterize the sources and nature of uncertainty. Ideally, probability distributions of potential benefits, costs, and net benefits should be presented.[43] OMB also recommends considering certainty equivalents, stating that in general, variations in the discount rate are not the appropriate method of adjusting net present value for the special risks of particular projects. In some cases, it may be possible to estimate certainty-equivalents, which involve adjusting uncertain expected values to account for risk.[44]

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[39] Stokey and Zeckhauser, *A Primer for Policy Analysis*, 174.

[40] Eugene L. Grant, W. Grant Ireson, Richard S. Leavenworth, *Principles of Engineering Economy* (New York: John Wiley, 1990), 411.

[41] Pearce and Turner, *Economics of Natural Resources and the Environment*, 224.

[42] William D. Nordhaus, "Discounting and Public Policies That Affect the Distant Future," ch. 15 in *Discounting and Intergenerational Equity*, (Washington, D.C.: Resources for the Future, 1999), 158.

[43] White House Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, section 9.

[44] Ibid.

Consequences of Using a Social Discount Rate on the Levelized Costs and Present Value of a Combined-Cycle Plant

Present values and levelized costs are frequently used to compare technologies. A levelized cost is the product of the present (discounted) value of a stream of project costs and a capital recovery factor that yields a constant annual payment, which, over the life of the project, is equivalent to the stream of yearly costs. Thus, the process of discounting is integral to calculating both present values and levelized costs.

In this section, staff investigates the effects of applying two discount rates on the present values and levelized costs of the fuel-based and total costs of a hypothetical natural gas-fueled combined-cycle power plant.[45] The two discount rates used for the calculations represent a private cost of capital (the weighted average cost of capital used by a utility) and a social cost of capital.

Staff calculated present values and levelized costs for a natural gas-fired combined-cycle unit starting operation in 2008 to illustrate the effect that two different discount rates have on such costs. Staff compared nominal (includes a factor for inflation) discount rates of 5 percent (representing a social discount rate of 3 percent plus 2 percent inflation) and 10.65 percent (representing a utility WACC of 8.58 percent plus a 2.07 percent inflation factor).

Table 1 presents the results of staff's calculations on the effects of varying discount rates on the present value and levelized costs for the natural gas fuel portion only of combined-cycle costs. As discussed earlier, lower discount rates have the effect of raising the present value of a cost series. For annual fuel cost escalation rates ranging from 1 to 6 percent, Table 1 shows that lowering the discount rate from 10.65 to 5 percent raises the present value of the fuel costs between 55 and 69 percent. The process of levelizing, however, tends to mask these differences as the present costs are spread out over time. The last column shows that once levelized, the cost differences for the two discount rates range from approximately 2 to 10 percent. Thus, the magnitude of the change due to discount rates depends on the analysis performed, whether examining present values or levelized costs.

[45] Joel Klein of the Electricity Assessments Office provided estimated costs from the Energy Commission's Cost of Generation model.

Table 1[1]
Effect of Discount Rates on the Present Value and Levelized Cost of Natural Gas in a Combined-Cycle Power Plant[2]

	Present Value ($/MWh)			Levelized Cost ($/MWh)		
Annual Fuel Price Escalation Rate (percent)	5 Percent Discount Rate	10.65 Percent Discount Rate	Percentage Difference	5 Percent Discount Rate	10.65 Percent Discount Rate	Percentage Difference
1	870	560	55	69.78	68.68	2
2	945	598	58	75.79	73.41	3
3	1,028	641	60	82.51	78.64	5
4	1,122	688	63	90.03	84.43	7
5	1,227	740	66	98.45	90.83	8
6	1,345	798	69	107.89	97.94	10

[1] The costs presented here are illustrative only for comparing discount rate effects. They should not be used as an indication of current staff estimates of technology or fuel costs.
[2] Assumes a 20-year plant life, 2008 startup, 12-year debt term, 20-year federal and state tax life and 40/60 debt/equity ratio
Source: Energy Commission staff

Whereas **Table 1** presents cost differences due to differential discount rates for only the fuel portion of combined cycle costs, **Table 2** shows that if capital costs are included so that total plant costs are compared, the differences due to the discount rate changes are smaller. This is because capital costs remain constant and are discounted only at the utility WACC. Lowering the fuel-related discount rate from 10.65 to 5 percent raises the present value of total plant costs between 34 and 48 percent and the total levelized costs between 1 and 7 percent.

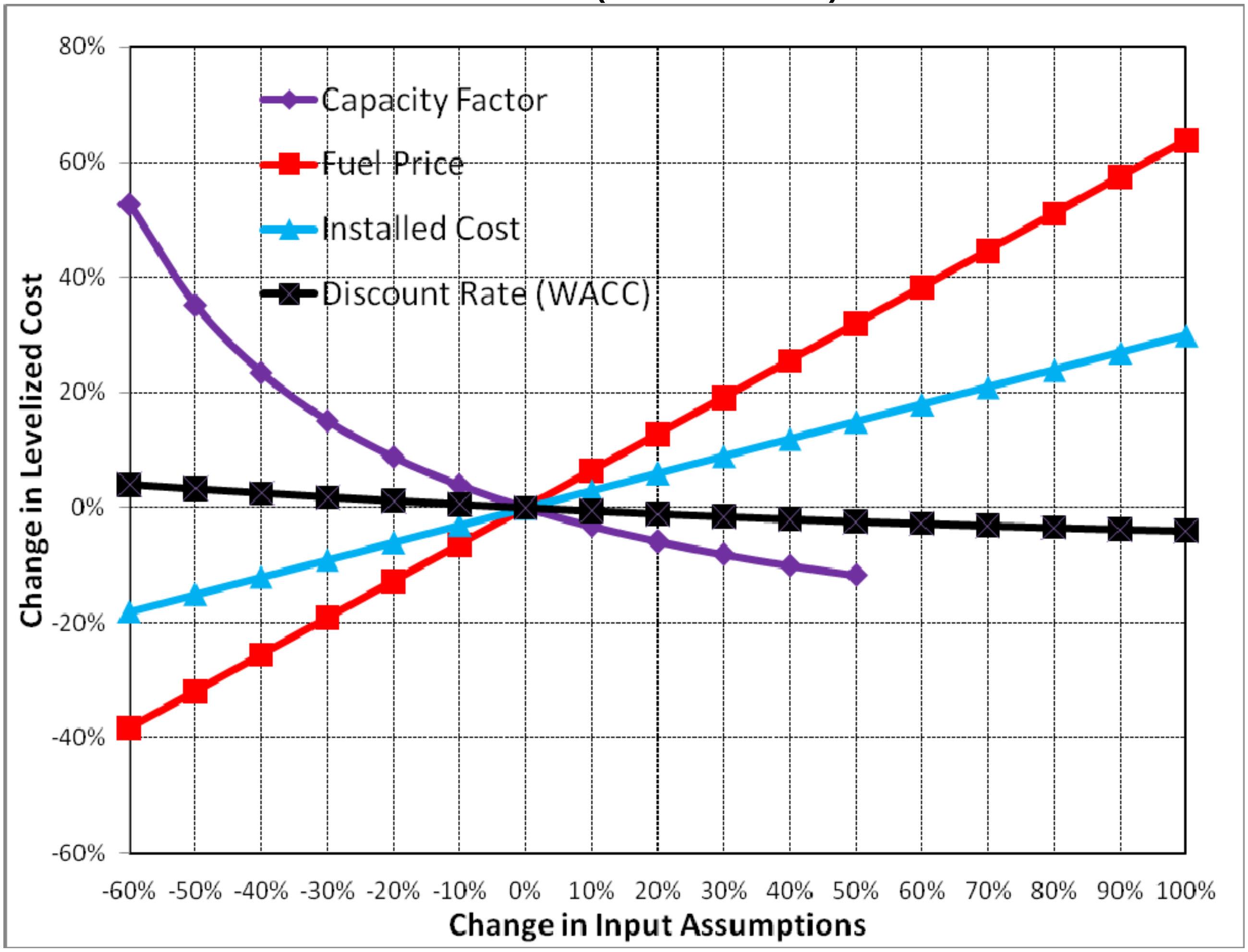
Table 2[1]
Effect of Fuel Discount Rates on Total Present Value and Levelized Costs of a Combined-Cycle Power Plant[2]

	Present Value ($/MWh)				Levelized Cost ($/MWh)			
Annual Fuel Price Escalation Rate (percent)	Non Fuel Costs @ 10.65 Percent Discount Rate	Total Costs @ 5 Percent Fuel Discount Rate	Total Costs @ 10.65 Percent Fuel Discount Rate	Percentage Difference	Non Fuel Costs @ 10.65 Percent Discount Rate	Total Costs @ 5 Percent Fuel Discount Rate	Total Costs @ 10.65 Percent Fuel Discount Rate	Percentage Difference
1	349	1219	909	34	42.87	112.65	111.55	1
2	349	1294	948	37	42.87	118.66	116.29	2
3	349	1378	990	39	42.87	125.38	121.52	3
4	349	1471	1037	42	42.87	132.90	127.30	4
5	349	1576	1090	45	42.87	141.32	133.71	6
6	349	1694	1147	48	42.87	150.77	140.81	7

[1] The costs presented here are illustrative only for comparing discount rate effects. They should not be used as an indication of current staff estimates of technology or fuel costs.
[2] Assumes a 20-year plant life.
Source: Energy Commission staff

Figure 1 illustrates the comparative effects of changing selected input assumptions on the levelized costs of a combined-cycle power plant. The discount rate, installed capital cost, fuel cost, and capacity factor (percentage of time the plant operates) were varied individually over a range of values to illustrate the relative importance each has on the levelized cost of electricity generated by the combined-cycle unit. For example, as the fuel price varies from 60 percent lower to 100 percent higher than the base value, the total levelized cost of electricity from the plant ranges from about 40 percent less to somewhat over 60 percent higher. Varying plant installed cost from -60 to +100 percent changes levelized prices from about -20 to about +30percent. Varying the discount rate over the same range affects total levelized plant costs on the order of about ± 5 percent.

Figure 1
Effect of Changing Input Assumptions on Combined Cycle Levelized Costs[1]
Start Year 2008 (Nominal 2008 $)



[1]Base values: capacity factor = 60%, fuel price = $8.21, installed cost = $883.00, discount rate = 10.70%
Source: CEC staff

To summarize, lowering the discount rate from 10.65 to 5 percent raises the present value of the fuel costs between 55 and 69 percent for annual fuel escalation rates ranging from 1 to 6 percent. Levelizing masks that difference, so that the levelized cost differences for the two discount rates range from approximately 2 to 10 percent. Similarly, lowering the discount rate raises the present value of total plant costs between 34 and 48 percent and the total levelized costs between 1 and 7 percent. Finally, changes in the discount rate affects the total levelized cost of electricity from the plant less than changing fuel price, plant installed cost, or capacity factor.

Summary and Questions

The 2008 IEPR scoping memo directed staff to examine the consequences of applying a social discount rate to natural gas prices in utility long-term procurement to account for the cost risk associated with natural gas-based generation compared to non-fossil alternatives. Staff reviewed the literature on discount rates to investigate their use and how they may be adjusted for risk.

The choice of a discount rate can be based on many factors, but is frequently based on the opportunity cost of capital. Whether this should reflect the opportunity cost of a firm, an individual, or society depends on the nature of the project under consideration and the source of funding for the project or the types of funds that will ultimately be affected by the project.

For projects funded by a corporation with the benefits and costs allocated to shareholders, the firm's weighted average cost of capital is often chosen to be the discount rate. For projects funded by the public sector, some measure of the public's opportunity cost may be appropriate, but the level depends on other factors. OMB points out that public investments and regulations displace both private investment and consumption and the marginal pretax rate of return on an average investment in the private sector is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in that sector. When regulation primarily and directly affects private consumption, OMB found the use of a "social rate of time preference" to be appropriate, or the rate at which the average saver uses to discount future consumption, as approximated by the real rate of return on long-term government debt.[46]

A social discount rate has also been deemed appropriate in the case of projects determined to be "public goods" projects. Energy Commission staff posited that high voltage transmission infrastructure in a restructured market has increasingly become a public good and that state decision makers should apply the "social rate of discount" when using the "societal test" to make a decision on the economic value of a project.[47] The Energy Commission agreed and the *2004 IEPR Update* recommended using a social discount rate, comparable to that used for its buildings and appliance standards, for evaluating the costs and benefits of transmission investments in a properly focused state transmission planning process.

The previous section illustrated the consequences of applying a social discount rate to natural gas costs of a combined-cycle power plant. Staff found that using a social discount rate compared to a private discount rate raises the present value of fuel costs to a far greater degree than it raises levelized costs, because of the masking effects of the levelizing process. A similar effect was observed when examining total plant costs. Finally, changing the discount rate affects

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[46] White House Office of Management and Budget, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, Circular No. A-94, October 29, 1992.

[47] California Energy Commission, *Upgrading California's Electric Transmission System: Issues and Actions for 2004 and Beyond*, CEC-100-04-004D.

the total levelized cost of electricity from the plant to a lesser degree than changing fuel price, plant installed cost, or capacity factor.

The question regarding whether to adjust discount rates to reflect the risky nature of some cash flows has been extensively discussed. EPRI compares financial theory and decision analysis, pointing out that financial analysis estimates the market values of an investment and often uses a discount rate that is adjusted for risk and applies this rate to a single expected cash flow. In contrast, decision analysis provides decision makers with a method for choosing among a set of alternatives with uncertain outcomes, laying out uncertain cash-flow scenarios, and evaluating each using a risk-free (unadjusted) discount rate. Thus, the advisability of adjusting discount rates for risk would seem to depend on the analytical method used.

Awerbuch proposes using risk-adjusted discount rates for utility planning purposes, consistent with textbook finance. EPRI argues that the relevant cost of capital is specific to the project, not the corporation and that risk-adjusted discount rates derived from interest rates and risk premiums observed in the capital markets should be selected in light of the cost characteristics of the investment, rather than the profit characteristics.

Other sources cautioned against adjusting discount rates to account for risk, citing a number of conceptual and analytical difficulties:

- It has not been shown that there is an economically meaningful relationship among the expected value of uncertain costs, the certainty equivalent of expected costs, and the discount rate. Absent this relationship, the use of a low discount rate to reflect uncertain costs is arbitrary.
- Raising the discount rate in effect changes the tradeoff rate between payoffs in different periods, yet there is no inherent reason why uncertainties about the amounts of future payoffs should affect the way we are willing to trade off one year's payoff against the following year's. The correct analytical approach is to separate the question of risk-free discount rate from the question of how we value risky outcomes.
- The variance of cash flows alone is not an adequate measure of risk in this context, and discount rates will generally not vary with risk in a linear fashion.
- The presence of uncertainty and risk should not be handled by adjustments to the discount rate, for such adjustments imply a particular behavior for the risk premium which is hard to justify.

The caveats against adjusting discount rates to account for risk seem to be predicated on the idea that, if available, there may be more appropriate ways to account for risk, such as how we value risky outcomes, identification of probabilities, and focused policy analysis. Adjusting discount rates may be advisable when performing direct project-by-project comparisons, or if there are no other means available to consider risk in an analysis.

The Energy Commission recognized that the long-term planning process for California's investor-owned utilities would be the appropriate forum in which to consider the comparative risk of different utility investments. The *2007 IEPR* stated:

> Accordingly, the Energy Commission intends to make the development of a common portfolio analytic methodology a core focus of the 2008 IEPR Update, with the clear objective of influencing the long-term procurement plans filed by the investor-owned utilities with the CPUC in December, 2008.[48]

In its consideration of the 2006 IOU resource plans, the CPUC issued Decision 07-12-052 (December 20, 2007), which stated (p. 76):

> The methodology established in the Scoping Memo for long-term renewable resource planning was not as robust as we believe is necessary for effective resource planning decisions; therefore, we direct the IOUs to work with ED staff to refine this planning methodology. We anticipate methodology that employs an integrated portfolio approach.

The CPUC has since convened a successor Long-Term Procurement Planning Rulemaking (R.08-02-007) that contains the following issues within its scope: standardized resource planning practices, assumptions and analytic techniques applied in long-term procurement plans based on an integrated resource planning framework (p. 10). Activities to date in R.08-02-007 lead Energy Commission staff to anticipate that the next round of utility long-term procurement plans will indeed be based on an integrated resource planning framework incorporating risk-based portfolio analysis. Gas price risk will certainly be incorporated within such a planning framework, meaning that a suitably wide range of future prices and thus, risks, could be considered.

In order to assist staff and the Energy Commission in further considering the application of a social discount rate to future fuel prices and the consequences of doing so, staff raises the following questions:

1. If utilities are required to meet a Renewables Portfolio Standard (RPS), is use of a risk-adjusted discount rate for natural gas cost streams appropriate when evaluating portfolio costs? If the RPS has been put in place to mitigate fuel cost risk? If it has been implemented for reasons other than fuel cost risk? If the RPS does not represent a binding constraint (that is, if least-cost, best-fit procurement yields amounts of renewable energy in excess of the RPS)?

2. If the CPUC's Long-Term Procurement Proceeding requires that utility long-term procurement plans be evaluated over a suitably wide range of natural gas prices and associated uncertainties, would using a risk-adjusted discount rate for natural gas cost streams be appropriate when determining portfolio costs? This assumes that the

[48] California Energy Commission, *2007 Integrated Energy Policy Report*, 48.

purpose of determining the sensitivity of portfolio costs to different fuel prices is to evaluate the tradeoff between expected portfolio costs and risk.

3. Should risk-adjusted discounting of fuel costs be used when comparing bids received in response to an RFO? In the presence of an RPS? When accompanied by portfolio analysis as described in Question #2? If not, are there other adjustments for risk that can or should be used?

4. If fuel costs should be discounted at a risk-adjusted rate, are there risky costs related to other technologies that should be similarly treated to maintain analytical consistency?

5. If risk-adjusted discounting is appropriate for present valuing natural gas costs, should the discount rate be based on a social discount rate or some other measure? If based on a social discount rate, how should that rate be derived?

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