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#82

STATE OF CALIFORNIA PUBLIC UTILITIES COMMISSION

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TESTIMONY OF PAUL CHERNICK and EMILY CAVERHILL, PLC, Inc.

For Environmental Adders Workshop

ON BEHALF OF

Alliance for Renewable Energy and Conservation ("AREC")*

Febuary 21, 1990

* AREC is an emerging "ad-hoc" coalition of private industry and environmental organizations who are joining to promote conservation and renewable electricity generation technologies.

STATE OF CALIFORNIA
PUBLIC UTILITIES COMMISSION

TESTIMONY OF

PAUL CHERNICK
EMILY CAVERHILL
PLC, Inc.

ON BEHALF OF

February 21, 1990

Q: Mr. Chernick, please state your name, occupation and business address.
A: My name is Paul L. Chernick. I am President of PLC, Inc., 18 Tremont Street, Suite 703, Boston, Massachusetts.
Q: Mr. Chernick, would you please briefly summarize your professional education and experience?
A: I received a S.B. degree from the Massachusetts Institute of Technology in June, 1974 from the Civil Engineering Department, and a S.M. degree from the Massachusetts Institute of Technology in February, 1978 in Technology and Policy. I have been elected to membership in the civil engineering honorary society Chi Epsilon, and the engineering honor society Tau Beta Pi, and to associate membership in the research honorary society Sigma Xi.

I was a Utility Analyst for the Massachusetts Attorney General for over three years, and was involved in numerous aspects of utility rate design, costing, load forecasting, and the evaluation of power supply options.

As a Research Associate at Analysis and Inference, and in my current position, I have advised a variety of clients on utility matters. My work has considered, among other things, the need for, cost of, and cost-effectiveness of prospective new generation plants and transmission lines; retrospective review of generation planning decisions; ratemaking for plant under construction; ratemaking for excess and/or uneconomical plant entering service; conservation program design; cost recovery for utility efficiency programs; and the valuation of environmental externalities from energy production and use. My resume is attached to this testimony as Appendix A.

Q: Mr. Chernick, have you testified previously in utility proceedings?

A: Yes. I have testified approximately sixty times on utility issues before various regulatory, legislative, and judicial bodies, including the Massachusetts Department of Public Utilities, the Massachusetts Energy Facilities Siting Council, the Illinois Commerce Commission, the Texas Public Utilities Commission, the New Mexico Public Service Commission, the District of Columbia Public Service Commission, the New Hampshire Public Utilities Commission, the Connecticut Department of Public Utility Control, the Michigan Public Service Commission, the Maine Public Utilities Commission, the Minnesota Public Utilities Commission, the Vermont Public Service Board, the Federal Energy Regulatory Commission, and the Atomic Safety and Licensing Board of the U.S. Nuclear Regulatory Commission. A detailed list of my previous testimony is contained in my resume. Subjects I have testified on include nuclear power plant construction costs and schedules, nuclear power plant operating costs, power plant phase-in procedures, the funding of nuclear decommissioning, cost allocation, rate design, long range energy and demand forecasts, utility supply planning decisions, conservation costs and potential effectiveness, generation system reliability, fuel efficiency standards, and ratemaking for utility production investments and conservation programs.

Q: Have you authored any publications on utility ratemaking issues?

A: Yes. I have authored a number of publications on rate design, cost allocations, power plant cost recovery, conservation program design and cost-benefit analysis, and other ratemaking issues. These publications are listed in my resume.

Q: Have you testified previously regarding the valuation of externalities?

A: Yes. I have testified before the Massachusetts Department of Public Utilities in Docket 88-67, Phase II, concerning the adequacy of Boston Gas's incorporation of externalities in least-cost planning; and before the Vermont Public Service Board in Docket 5330, concerning the evaluation of a proposed power purchase from Hydro Quebec. In addition, the report attached as Appendix C was filed with the Massachusetts DPU in Docket 89-239, on all-resource bidding and power supply planning, and I expect to be cross-examined by the Commission on that report.

Q: Have you been responsible for any presentations or papers on the valuation of environmental externalities?

A: Yes. I was asked by the New England Conference of Public Utility Commissioners (NECPUC) to address the NECPUC Workshop on Enviromental Externalities in Portsmouth NH, January 22, 1990. I also served as the faculty for the Externalities

Valuation portion of Lawrence Berkeley Laboratory's course (sponsored by DOE and NARUC) on Least-Cost Planning for commission staff members.

Q: Ms. Caverhill, please state your name, occupation and business address.

A: My name is Emily J. Caverhill. I am a Research Associate at PLC, Inc., 18 Tremont Street, Suite 703, Boston, Massachusetts.

Q: Ms. Caverhill, would please summarize your professional education and experience.

A: I received a Bachelor of Science degree in Chemical Engineering in May, 1984 from Queens University at Kingston, Ontario. I worked for two years at Petro-Canada Inc. as a Petroleum Engineer in Calgary, Alberta and became a professional member of APPEGA (the Association of Professional Engineers, Geologists, and Geophysicists of Alberta) in 1986, where I am currently a member in good standing.

I received a Masters of Business Administration in May, 1989, also from Queens University. In the summer of 1988, I worked as a Science Intern with the Conservation Law Foundation of New England where I investigated and wrote reports on a variety of environmental policy issues including submitting comments on federal pesticide policy, and preparing a report on Massachusetts proposed on-site waste management code.

I joined PLC, Inc. in July, 1989. Since then, my primary responsibility has been the valuation of environmental externalities of power generation, with some related work in other aspects of least cost planning. My work has been concentrated in valuing externalities which may effect near-term decisions in New England supply planning, that is the externalities from fossil-fired energy production. In addition to the work presented in the report attached as Appendix C, I have recently been reviewing other direct costing studies for SO_2, NO_x and particulates to assess the viability of direct valuation of these important externalities.

Q: Have you contributed to any presentations or papers on the valuation of environmental externalities?

A: Yes. I have contributed to most PLC, Inc. externality-related products over the last six months. Specifically, I co-authored the report to the Boston Gas Company on "Valuation of Externalities from Energy Production, Delivery, and Use". I also contributed to Mr. Chernick's testimony in Vermont PSB 5330. I am currently preparing a paper on the valuation of externalities to be presented at the Canadian Energy Association's Demand-side Management Conference in May; a draft of that paper is attached as Appendix D. My abstract for a paper on incorporation of externalities in least-cost planning has been accepted for the ACEEE 1990 Summer Study on Energy Efficiency in Buildings in California, in August.

Q: What is the purpose of this testimony?

A: This testimony discusses some of our previous work on the incorporation of environmental externalities in utility planning and pricing. We also discuss approaches for valuing externalities, the appropriate mechanism for including externalities, and the role of uncertainty in the valuation of greenhouse effects.

Q: Please discuss approaches for valuing externalities.

A: There are two basic approaches: direct estimation and cost-of-control. These approaches are discussed in Appendices C and D.

In general, our experience has been that the direct estimates are higher than the values derived from the costs of controls. For a number of reasons, which are covered well in the Appendices, control costs tend to be easier to apply, at least in the short run. The direct estimates we have derived confirm the general magnitude of the control-cost-based estimates.

Q: Given the range of approaches and estimates, is the Commission likely to encounter great difficulty in selecting an externality value?

A: We do not believe so. Some cost-of-control estimates will be lower than the social value of emission reduction, because they are not driven by marginal control measures. Some direct estimates will be low, because they assume low unit values for human health or other effects, or because they are computed for emissions from remote sites. Once these inconsistencies are accounted for, the range of values for a particular externality (e.g., the value per pound of a particular pollutant) does not tend to be very large.

The selection of values for major emissions to the environment is not particularly complex or difficult, compared to the array of choices the Commission makes on a regular basis, such as projecting loads, interest rates, and fuel prices, or setting returns on equity.

Q: Please discuss the appropriate mechanism for including externalities in setting power purchase rates.

A: Most of the externalities which are likely to be considered early in the process -- mostly air emissions, but perhaps also water pollution as well -- are produced by the generation of energy, rather than the construction and maintenance of plants to provide capacity. Hence, the value of avoided externalities should be added to the rate paid for energy produced by a QF. The QF's own externalities should be subtracted from the rate paid.

Utilities and regulators have proposed or used a variety of mechanisms for reflecting externalities in the selection of supply sources. These approaches have ranged from simple percentage adders to complex rating systems, in which points are assigned to resources for cost, externalities, and other characteristics. The percentage adders have no particular relationship to the value of externalities avoided; a purchase an existing coal plant, for example, is apt to be less expensive than building a BACT gas-fired combined cycle, but the coal plant externalities are almost certainly higher. In our experience, the point systems are usually arbitrary, and their effects are difficult to predict until all potential resources have been identified. Hence, we favor simply adding an externality credit to the direct avoided costs. That credit would be equal to the difference in emissions, times the value per unit of the emission. The credit can be calculated for any unit of output (such as annual generation by the QF), but it is apt to be convenient to state the credit per kWh of QF generation.

Q: How does uncertainty affect the value of greenhouse mitigation efforts?

A: Some observers have argued that the uncertainties in the current and future magnitude of global warming imply that no action should be taken at this time, other than expanded research. We strongly disagree. In fact, the uncertainties regarding global warming argue for greater restraints on greenhouse gases, and hence greater efforts to achieve those restraints, than would be appropriate if we knew for certain that the future of global warming (and the effect of our actions on that future) would equal today's best estimates.

Investments in greenhouse mitigation are a form of insurance. In general, we are willing to spend more on an insurance policy (for medical costs, automobile repairs, replacement of a home, and the like) than the expected present value of the payouts. People make this choice quite rationally, since the insurance will pay off when and if it is most needed, and will mitigate the costs of adverse events.

In other words, we willingly part with considerable sums of money today (when we are relatively well off, compared to the possiblities we insure against), so that the worst possible outcomes will be less terrible. We do this, knowing that we will not receive any payout if nothing goes wrong.

If the greenhouse effect is worse than our best estimates, the small investment we make today will produce large savings (in energy, food resources, avoided coastal protection, etc.) in a future world which will be highly stressed, very poor, and very grateful for those benefits. If the greenhouse effect is less severe than the current expectation, the future world will be relatively well off, and will barely notice our diversion of resources toward greenhouse mitigation and away from other pursuits. As in any other risky situation, greenhouse insurance is worth much more than the expected value of the payout.

Even the current best estimates of the scope and consequences of global warming are quite serious, and justify prompt and vigorous action. (See Krause, Bach, and Koomey, **Energy Policy in the Greenhouse**, International Project for Sustainable Energy Paths, El Cerrito CA, 1989, for a discussion of these issues.) Uncertainty only increases the urgency of action.

Q: Does this conclude your testimony?

A: Yes.

APPENDIX A

to the

COMMENTS OF V. JOHN WHITE

Prepared by
Paul Chernick
Emily Caverhill
PLC, Inc.

ON BEHALF OF

LUZ INTERNATIONAL
US WINDPOWER
CALIFORNIA ENERGY COMPANY

CALIFORNIA ENERGY COMMISSION
Docket 88-ER-8

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APPENDIX A
to the
COMMENTS OF V. JOHN WHITE

A. THE ROLE OF EXTERNALITIES IN ELECTRIC UTILITY PLANNING

1. Importance of Explicitly Valuing Externalities

There is no viable alternative to including the value of environmental externalities in resource planning and acquisition decisions. Each decision -- sizing a conservation program, approving a pumped-hydro facility, selecting preferred fuels -- creates a set of environmental effects, even after all mitigation measures have been accounted for. Evaluating choices and alternatives without explicit consideration of environmental effects will almost certainly result in higher social costs from the energy supply system.

The CEC's decision on valuing externalities in this proceeding will be only a beginning step. It is important that this first step be on a path which will lead to a comprehensive and workable system for valuing externalities. To start off right, the CEC externality valuation approach should include all important externalities for which valuation information is available. To the extent that other effects (additional air emissions, water emissions, fuel accidents and spills, etc.) are quantified in later proceedings, a properly constructed externality-valuation approach can incorporate them at that time.

The need to include additional externalities, such as for hydro-electric development, or nuclear life extension, argues strongly for determining dollar values for externalities and for simply adding those dollar values to the direct internal costs in determining the total cost of each resource. Other states have attempted to use simplistic credits for externalities, such as percentage adders to direct costs and complex ranking schemes, which do not directly value externalities and which generally do not lend themselves to straightforward expansion of the set of externalities under consideration.

It is also important that the CEC use the best available estimates of societal value for each pollutant. The use of arbitrary values in this proceeding will simply delay the construction of a comprehensive and unbiased analytical framework.

The local, regional and global effects of residual emissions should be incorporated into the planning process. Local effects include the contributions of SO_2, NOx, ROG, TSP and CO to degraded ambient air quality, including the formation of ozone, smog (with its complex nitrogen compounds) and PM10 (which includes nitrates, sulfates, and carbonaceous particles, produced by SO_2, NOx, and ROG, respectively). The local air pollutants have implications for local health, visibility and damage to vegetation and materials.

Regional effects include the acid rain damages caused by SO_2 and NOx emissions, regional haze, and additional health and visibility effects due to the transport of small particulates. Global effects include the contribution to global warming due to the emissions of greenhouse gases, particularly CO_2, but also methane and carbon monoxide.

The current system of utility planning effectively values all residual emissions at zero. Continuing that system would result in lower air quality for an extended period of time, due to the delay in the pursuit of socially cost-effective conservation and clean generation technologies. The longer-term effect of the current system is likely to be higher revenue requirements, to cover the costs of belatedly correcting the decisions made in the near future. It will be more expensive to go back and upgrade conservation investments than to design them to capture the full potential for cost-effective efficiency in the first place. It will be more expensive to build combined-cycle plants in the 1990s, and back them out with renewables in the next century, than to build the renewables in the first place.

2. The Importance of Residual Emissions

(a) Pollution occurs by the pound, not by percent

Some utilities have argued that the emissions of criteria pollutants from utility power plants should not be considered in CEC's planning analyses. This argument has been largely grounded in the assertion that the level of residual emissions allowed by air-quality regulators (the various AQMDs, CARB, and USEPA) must be tolerable and benign, or else that level would not be tolerated. This assumption is based on a fundamental misunderstanding of the damages caused by environmental emissions.

Emissions cause harm by contributing to higher levels of ambient air pollution, and thus to higher levels of deposition on sensitive systems, including human lung tissue, vegetation, aquatic ecosystems, building materials, and others. Ambient pollutant concentrations also affect visibility. None of these effects is at all sensitive to the origin of the pollutants, other than in a geographical sense. The effect of a pound of pollutant is the same, whether it comes from a large source or a small source, from an uncontrolled gas turbine or one with SCR. Therefore, until air quality is good enough that reduced pollution has no additional benefit for the protection of health, property, visibility or ecosystems, further reduction of residual emissions from utility plants will always have some value.

Air quality regulation aims to achieve a tolerable level of air quality at a tolerable cost. Regulators require reductions of emission rates down to levels deemed to be technologically and economically feasible; they do not require (and could not achieve) the elimination of all environmental effects from the operation of a utility plant. For any given set of emission factors (expressed in lb/MMBTU, for example) reducing utility plant emissions through increased efficiency or construction of cleaner renewables will improve air quality and reduce the social costs resulting from pollution.

In short, the effect of a power plant on the environment depends on the pounds of pollutant it emits, not on the percentage reduction it has achieved from its uncontrolled or historical emissions.

(b) A pound from a small sector is as important as a pound from a large sector

SCE has argued that recognition of air emissions from its plants is unnecessary or unfair, since utility operations produce only a small fraction of emissions for many pollutants. For example, the transportation sector has a much larger effect on ROG and NOx emissions than does the utility sector.

This issue is relevant to the determination of the total improvement in air quality that can be achieved through measures in a particular sector, but is not relevant to the determination of the value of reductions per pound of pollutant. A pound of NOx from a utility plant is as destructive as a pound of NOx from a car, and total emissions per power plant are greater than total emissions per car. The fact that there are more cars than power plants does not make each pound of automotive emissions more important, or the utility emissions less important.

Reductions in utility emissions alone will not be sufficient to provide acceptable air quality in the South Coast air basin. Similarly, controls on small dry cleaners, or on ethnic bakeries, or on imported sports cars, will not be sufficient in themselves. If SCE logic were extended to other sectors, defined in sufficient detail, no one source would seem large enough to warrant control, and no progress would be made in cleaning up California's air. Fortunately, the air-quality regulators recognize that all sources contribute to the costs of air pollution, and have attempted to control emissions from all sectors, to the extent that such control is economic.

(c) In SCAQMD, Electric Substitution will tend to increase the importance of electric emissions in air quality

SCAQMD has proposed the substitution of electricity for distillate oil products (gasoline and diesel oil) in transportation, and for a number of industrial processes. To the extent that electrification is likely to improve air quality in the South Coast air basin, it is desirable. However, the electric generation becomes a more crucial part of the air quality problem with these substitution strategies.

As demonstrated in the Staff Draft of Chapter 8 of the Initial Policy Report, the addition either of electric cars or of the industrial electrification would increase annual electric utility NOx emissions in 2009 by 52-58% (see Table 5). The industrial strategy alone is enough to raise peak day emissions virtually to the limit imposed by Rule 1135 (see Table 8). Combining the two strategies could more than double utility NOx emissions in 2009, and increase peak-day emissions to 28% over the Rule 1135 limit.[1]

If the fuel-substitution proposed by SCAQMD is pursued, reductions in electric-utility air emissions will become increasingly necessary.

3. The Relevance of Regulatory Requirements

(a) Rationale for deriving cost of emissions from cost of required controls

The cost of pollution control is sometimes described as if it were a proxy for the cost of emissions. In fact, the costs of controls can be considered as providing direct information on the value of emission reductions, under either of two theoretical approaches.

First, the cost of the required controls provide an estimate of the price that society is willing to pay to reduce the pollutant. If legislators and regulators require measures which cost as much as $2/lb to reduce sulfur emissions, it seems reasonable to assume that reducing emissions from those sources must be worth at least $2/lb, and that reductions from other sources (as by conservation or fuel choice) must also be worth $2/lb. This is the rationale behind the "revealed pref-

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1 This computation assumes linearity in emissions. In fact, incremental generation appears to be significantly dirtier than average generation. For the 2009 peak day, base-case emissions are 0.17 lb NOx/MWH. The increase of 48.1 GWH due to electric vehicles increases emissions 4.5 tons, or 0.19 lb/MWH; the 49 GWH of generation for industrial electrification increases emissions 5.8 tons, or 0.24 lb/MWH. Given this non-linearity, adding the two substitution strategies together will probably increase emissions by more than the sum of the increases for the separate strategies.

erence" approach to the use of control costs for valuing externalities.

Second, the costs of required controls may directly establish the social benefits of reducing emissions, to the extent that they define the direct pollution-control costs which can be avoided by an exogenous reduction in emissions. If the objective of environmental regulation is the maintenance of a given level of ambient air quality, the construction of a less polluting plant, or the reduction in output requirements due to conservation, will allow regulators to back down from the most expensive control measures which would otherwise have been required.

One important aspect of the implied valuation approach is that it is not an estimate of costs which may be internalized by future requirements. Estimates of internalized control costs should be added to the estimates of the cost of new sources, but by definition are not externalities.

(b) CEC can build on decisions by air-quality regulators

One major advantage to the cost-of-control approach is that CEC can rely on the expertise developed by the air quality regulators at the regional, state, and federal level, without reinventing the wheel. Requirements for controls have already been established, incorporating regulatory decisions regarding the cost of emission reductions which are cost-effective and necessary to achieve reasonably clean air.

Relying on the determinations of air-quality regulators, the CEC need not address such issues as PG&E's claim that NOx emissions improve air quality in the Bay Area. This issue has been litigated before the air-quality regulators, and they have reached conclusions that are embedded in their respective regulations. Repeating this review would be duplicative and counterproductive.[2]

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2 The externality values proposed below would place a lower value on NOx emissions in the Bay Area than in the South Coast. This approach captures the rele-
(Footnote continued)

4. The Value of Emission Reductions Should be Derived from the Marginal Cost of Controls

Another important aspect of the implied valuation approach is that only the marginal cost of control matters. From the "implied preference" perspective, the fact that many required controls are inexpensive, or even that some inexpensive controls have not yet been required,[3] is irrelevant to the determination of the highest price society is willing to pay. From the avoided-control-cost perspective, the appropriate estimate of the social cost of control is the highest-cost item which will be required, since reduction of utility emissions (due to conservation or low-pollutant generation) will allow that most expensive measure to be avoided.

For example, if we assume (using values from the New York State 1989 Energy Plan, for illustrative purposes) half of the required NOx reductions can be achieved with low-NOx burners (LNB), at $400/ton, and the other half will require upgrading from LNB to selective catalytic reduction (SCR), at $20,000/ton, any reduction in NOx emissions will allow for the backing out of some of the SCR, saving $20,000/ton.

Thus, residual emissions should be valued at least at the marginal cost of abatement per pound of pollutant. As the Massachusetts DPU has recognized (MDPU 86-36G, 12/6/89, page 86), costs-of-control tend to understate the value to society of reduced emissions. The

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(Footnote 2 continued from previous page)
vant portion of PG&E's position: NOx emissions in the Bay Area are not as serious a problem as similar emissions in the SCAQMD basin.

3 Some inexpensive measures may not be required because they would burden very vulnerable parties, such as small businesses, because they would impose additional costs on parties with special responsibilities for other pollution reductions (e.g., the Clean Air Act amendments are likely to temporarily exempt utilities from most air-toxics controls, since the utilities will bear most acid-rain cleanup costs), or because the administrative burdens would be excessive, especially for small emitters.

effects of marginal emissions, the level of regulation, and thus the value of reducing some emissions will depend on the affected region: the values within SCAQMD are likely to be higher than those in the rest of California, which are likely to be higher (at least for some pollutants) than those outside of California.

5. The Best Data on the Record for Costs of Criteria Pollutants

Only two parties have provided serious estimates of the control costs (or any other measure of value) for the criteria pollutants: the Staff and IEP. Staff provides estimates of the value of pollution reduction for California and for out-of-state generation, while IEP provides SCAQMD, other California, and out-of-state values.

The Staff's estimates for the value of emissions in California is computed from the costs of measures required by SCAQMD's AQMP Tier 1 controls. The results are hence more appropriate for valuing emissions in SCAQMD than those in the state as a whole. Since the Tier 1 controls are the least expensive proposed measures, SCAQMD has actually indicated that pollution control is considerably more valuable than these Tier 1 figures. For each pollutant, column 1 of the attached Table 1 lists the highest cost reported by Staff for the measures in the SCAQMD plan. These costs are stated in an unusual manner, as one-tenth of the present value of the control costs over ten years. In its presentation dated March 7, 1990, Staff described how these values can be converted to real-levelized costs, by multiplying them by 1.40. Column 2 shows the levelized costs for the marginal controls listed by Staff. Column 3 provides IEP's estimates of SCAQMD's marginal costs, drawn from SCAQMD's published values of control used for evaluating the cost-effectiveness of controls on small businesses.[4] The values used in evaluating controls on small business-

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4 It appears that these value are reported in SCAQMD's present-value dollars, and should be restated in the same manner as the Staff's data to reflect real-levelized costs. That treatment would increase the IEP figures by 40%, but they would still be lower than the corrected Staff marginal cost figures.

es (with limited management resources and restricted access to capital) may well be lower than SCAQMD would apply in evaluating controls on larger firms, such as utilities. In each case, the marginal value of control identified by the Staff is in fact higher than the IEP estimate. The appropriate levelized values per ton are $87,500 for NOx, $35,000 for SOx, $41,000 for PM10, $35,000 for ROG, and $760 for CO.

For California outside SCAQMD, only IEP provides estimates of the costs of control. These estimates, shown in Table 2, are based on particular identified control strategies, such as the requirement of SCR on small cogenerators, the requirement that #6 oil not exceed 0.5% sulfur, and the mandating of vapor recovery at gasoline pumps. It is likely that the true value of emission reductions is higher and that other more expensive measures have been required, at least in some AQMDs. The Staff provided estimates of the costs of complying with NSPS, which also apply in all AQMDs. The NSPS costs are generally lower than the costs of control identified by IEP, except for SOx. The recommended values in Table 2 are the best current estimates of the non-SCAQMD California values of emission reductions: $18,800/ton for NOx, $3,600 for SOx, $9,000 for PM10, and $1,130 for ROG. These are reasonable values, although they should probably be increased as better information becomes available.

Both Staff and IEP estimate the costs of required controls for out-of-state generation. Table 3 shows the IEP estimates and the Staff estimates, with the latter divided into retrofit and NSPS costs. NSPS costs are required nationally; no pollutant should be valued at less than the cost imposed by NSPS. Since only one source estimate is available for each of PM10 and ROG, the choice is simple, at $9,000 and $665 per ton, respectively. For sulfur, the Staff value is higher than IEP's estimate, and is a better estimate of the marginal value. The staff retrofit value is only slightly higher than the NSPS estimate; given the likelihood of retrofit requirements at least some of the out-of-state plants, the retrofit value of $4,000/ton is a better estimate of the marginal cost of control.[5] For NOx, retrofits are likely

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5 Retrofit of sulfur control may be required for visibility considerations in particular parks. In addition, the Clean Air Act Amendments would require (Footnote continued)

to be required to meet the Clean Air Act amendments past the year 2000, so the relevant range lies between Staff's $2,000/ton and IEP's $2,700 per ton. Given the uncertainties in the exact cost of mitigation measures within this range, we recommend that CEC use the average of the retrofit estimates, or $2,350/ton NOx.

SCE has argued that NOx and SOx emissions out-of-state are of little consequence, on the grounds that there is no acid rain problem in the inland West. This is simply not the case. Acid rain in the West has become a significant problem, resulting in widespread damages to forests and ecosystems. The attached research review article from Nature discusses the role of acid rain in the Colorado Rockies as a contributor to decimation of amphibian species. The article describes amphibians as "'canaries in a coal mine' . . . likely . . . to be good early indicators of environmental decay." As outlined by the Environmental Defense Fund in the attached testimony, the National Park Service has identified major visibility impairments in the West. In addition, acid gases contribute to human health costs and to haze and visibility problems, which are very important in the parks and recreational areas of the inland West.

6. Estimation of the Cost of Greenhouse Gas Emissions

(a) Global Warming is almost certain to be a major problem in future

While there is doubt about the rate of global warming, and about whether the anthropogenic warming is yet discernable against the background noise of normal variability, there appears to be few in the scientific community who doubt that continued release of greenhouse gases will eventually cause large changes in climate, with potentially expensive and disastrous consequences.

(Footnote 5 continued from previous page)
reductions in sulfur emissions at existing western power plants, to offset emissions from new plants past the year 2000. Hence, reductions are essentially inevitable.

Given the uncertainties in the timing and magnitude of global climate change, and in its effects on ecosystems, storm intensity, rainfall patterns, coastal erosion and other factors, the CEC should view the incorporation of greenhouse effects in utility planning as a form of insurance. As is true for other types of insurance, additional expenditures to reduce the buildup of greenhouse gases will have relatively little value if the future is better than is currently expected, but enormous benefits if the future is much worse than our current best estimates. Just as reasonable people do not worry that they will buy insurance and not get sick, they should not worry that they pay slightly more in the short term to mitigate global warming and then find that the rate of warming is tolerable. Rather, we should worry that corrective actions will be too limited, and that the world of our declining years (and that which we leave to our children) will be marred by the tremendous ecological and human costs of global warming.

In addition to the insurance value of today's actions to mitigate global warming, the CEC should consider the effect its actions will play in creating an example for national and international action. While California's greenhouse emissions are a small part of the total world emissions, concrete action by California will, as it has done previously, provide a model for actions by other states, Congress, other countries and, potentially, international organizations. Specific incorporation of greenhouse effects as cost adders in California's utility planning process will be easy to transfer to other regulatory structures, legislation and treaty arrangements. Given California's leading national role in addressing other energy and environmental concerns, CEC leadership on valuing externalities is particularly important.

(b) Proposed alternatives for mitigating global warming

Three techniques have been offered for estimating the cost of mitigating or reducing carbon emissions: conservation, tree-planting, and scrubbing.

The Staff has proposed basing the cost of carbon mitigation on the cost of reducing atmospheric carbon through an urban heat-island conservation program proposed by Akbari and others from Lawrence Berkeley Labs. This program consists of painting roofs and roads in light colors to reflect solar heat and planting trees to shade buildings and to cool the general urban environment. The resulting reductions in cooling load are estimated to be so inexpensive that the proposed program is entirely justified by its energy savings. In fact, only about one fifteenth of the carbon savings are from absorption of carbon in the growing trees, while the rest is due to the reduction in fuel used to serve the air conditioners.[6] Since the program saves money, the net cost of carbon reductions is negative, as discussed in the testimony of Krause and Koomey, and in that of Akbari and Rosenfeld (1/25/90). If this program is as good as its advocates claim, it will be undertaken regardless of whether any global warming mitigation is required. It should be viewed as part of the base-case carbon-emission scenario, along with other efficiency programs that reduce revenue requirements. Unfortunately, the heat-island conservation program is not an available option for responding to the additional global warming from California's marginal energy decisions. Thus, the Staff's $7/Ton estimate of CO_2 is a gross understatement.

IEP has proposed deriving the cost of offsetting utility carbon emissions from the cost of planting trees in California commercial forests. That estimate is $14.70/Ton CO_2. This is a better approximation of the cost of sequestering carbon, but is still a clear understatement of the marginal cost of control. The trees to which IEP refers are being planted today, as part of the operations of forest-products companies. These trees are cost-effective to grow and harvest for wood and pulp. In contrast, the trees planted to reduce global warming will be more expensive than commercial trees, because they will be harder to plant (due to inaccessible sites, steep terrain, rocky soil or small sites, such as on highway median strips), be more expensive to grow (due to water or fertilizer needs), suffer more die-off, grow more

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[6] Since Akbari assumed that the power used to serve peak loads would be generated from coal, the actual costs of carbon reductions would be somewhat higher than he assumed. This factor does not detract from the cost-effectiveness of the program for load reduction.

slowly (due to climate, water, or soil conditions), or require removal of the land from other purposes (especially agriculture). After all, if those new sites were easier to grow trees on than existing sites, they would be used for forestry today.[7]

The testimony of Krause and Koomey provides an estimate of the cost of planting expensive trees. Combining higher planting costs and a slower growth rate, they derive a cost of $1048/Ton of carbon, or $286/Ton CO_2 reduction. However, this analysis assumes a 7% real discount rate and no taxes, producing a 9.4% capital recovery factor. Including realistic utility financing,[8] the real carrying charge is about 12%, raising the cost per ton CO_2 to $365/T. This estimate provides a sense of how expensive it may be to control marginal CO_2 emissions; IEP's estimate is clearly very optimistic.

In fact, tree-planting in itself seems unlikely to mitigate carbon emissions sufficiently, even if planting is extended to very expensive sites. Krause, Bach, and Koomey determined that, even with tree-planting on virtually all available land, slowing global warming to historical rates would require 80% reductions in anthropogenic carbon emissions from 1990 levels by 2030.[9] It is possible that this reduction in emission can be achieved through energy efficiency and non-fossil generation, but it is by no means clear that this will be feasible, unless utility planning explicitly values CO_2 at the cost of controlling emissions. Hence, we must look to estimates of the costs of CO_2 control for reductions

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7 To the extent that low-cost sites are available, they are required for offsetting infra-marginal carbon emissions. The marginal carbon emissions (such as those due to load growth), which can be avoided by conservation or by renewable energy, will require higher-cost mitigation.

8 Using tax-exempt financing is inconsistent with the assumptions used in other portions of the ER-90 analysis of utility costs.

9 **Energy Policy in the Greenhouse**, International Project for Sustainable Energy Paths, El Cerritto CA, September 1989.

beyond the range achievable by planting trees. Estimates of CO_2 scrubbing costs vary based on the amount of exhaust gas to be scrubbed. Estimates range from \$44 per ton of CO_2 (New York State Energy Office), to \$56 per ton (PLC, Chernick and Caverhill), to \$110 per ton (California Energy Company).

(c) Recommended value for carbon emissions

The most appropriate value for the CEC to ascribe to carbon mitigation is the cost of scrubbing, or \$150/ton. This value is lower than the cost of planting high-cost trees. There will be little damage if this value is higher than the market-clearing price for carbon mitigation. If conservation and non-fossil technologies can displace carbon emissions at costs lower than the cost of scrubbing, those less-expensive technologies will dominate the CEC's planning analyses and the CPUC's acquisition processes, and neither the scrubbers nor any technology as expensive as CO_2-scrubbing need ever be built.

If the CEC does not accept the cost of scrubbers as a reasonable estimate of the marginal cost of carbon control, then it should at least use a marginal forestation cost. Ideally, that value should be Krause and Koomey's high cost of \$365/ton CO_2. It is certainly higher than IEP's extremely modest \$14.70/ton.

(d) Recommended values of other greenhouse gas emissions

Only IEP provides information on determining the values of other greenhouse gases from the value of CO_2. While IEP's witnesses are correct that the values should be refined in the future, their initial estimates are reasonable, and the CEC should value methane at 25 times as much as CO_2 per ton, and NO_2 at 250 times as much as CO_2.

B. EMISSIONS ISSUES

1. The coal-fired portion of Northwest power

In preparing the draft IPR, Staff assumes that only 20% of the energy California purchases from the Northwest will be coal-fired. This assumption is totally inconsistent with reality. The Northwest is a hydro-dominated system with extensive ability to store energy between seasons; if any coal plant operates to serve Northwest load at any time during the year, load in any part of the year is virtually assured to increase the requirement for coal generation. In addition, the Northwest is interconnected with the coal-fired mountain states,[10] and any energy diverted from the Rockies to California increases the amount of coal-fired generation in the Rockies.

The Bonneville Power Administration recognizes that the marginal supply of energy in the region comes from fossil fuels. In its "Draft 1990 Resource Program Technical Report," BPA estimates that 100% of marginal Northwest generation is fossil-fired. An excerpt from that report is attached. Thus, all power from the Northwest, except for that generated from water which would otherwise have been spilled, should be treated as coal-fired for environmental analysis.

2. Role of offsets

SCE has argued that new generation does not necessarily produce new pollution, since new plants must obtain offsets from existing sources. It is important that the CEC distinguish between formal transactions and actual changes in emissions. For example, a new plant may obtain an offset through the installation of pollution controls on an existing source that would have been required to install similar controls within a few years under pending regulations. Thus, the new plant has actually offset its emissions for only a few years, even though it may have complied with the legal requirements necessary to receive a permit.

Similarly, the offset may have a short natural life. For example, early retirement of older vehicles will have some effect on emissions in the first few years, but most of the vehicles would probably have been

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[10] Most of the moutain-state utilities also serve portions of the Northwest.

retired long before the end of the power plant's life. Such offsets would have to be heavily discounted to reflect their short lives: the net lifetime emissions from the new utility plant will be only slightly reduced by the existence of the offsets.

Finally, if the CEC counts offsets in any way in evaluating the externalities of new fossil-fueled power plants, it should also allow for the purchase of similar offsets by QFs and in conjunction with efficiency programs. The reductions in emissions due to the QF/offset or conservation/offset combinations should be valued at the full cost of the emissions. The lowest social-cost energy supply may consist of a blend of energy efficiency, low-emission renewables, and purchases of reductions in emissions from other sources.

3. Importance of repowerings

Chapter 2 of the Staff draft of the IPR suggests that the CEC may favor repowerings in the South Coast air basin, in part because they would not be required by SCAQMD to obtain offsets for their emissions. This possibility increases the importance of valuing externalities explicitly and realistically in the planning process.

The repowered plants will produce at least as much pollution per MWH as would new units[11], and each pound of pollutant from a repowered plant is just as bad for the environment as is a pound from a new plant. The repowerings may have lower costs for other reasons, such as site preparation and transmission access, but they should not be treated as less expensive than new units simply because they are allowed to pollute more.[12]

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11 The repowered units would probably be somewhat less efficient, and hence produce somewhat higher emissions per MWH than new units.

12 The fact that the repowered plant occupies the site of a dirtier obsolete plant, whose emissions were partially grandfathered in the air quality regulations, does not reduce the biological or physical effects of the emissions from the repowered plant.

The Staff has also suggested that repowerings be treated as non-deferrable. There is no logical reason for this designation. If the true cost savings of the repowered plants more than compensate for their higher emissions, they may be preferred to new utility units. If the repowerings are sufficiently inexpensive, it is possible that few QFs will be competitive with them, even including realistic externality values; this issue will be resolved in the PUC's acquisition proceedings. Regardless of how inexpensive the repowerings may be, efficiency investments will almost certainly be less expensive, and will allow the deferral of at least some of the repowerings. Arbitrarily designating repowerings as non-deferrable will artificially restrict the development of efficiency investments and renewable technologies, and raise social costs.

Draft Chapter 2 (page 2-7) also suggests that any alternative to a repowering be required to provide all services provided by the repowered plant. This is another arbitrary constraint. Traditional determinations of avoided cost or of system have separated the benefits of a displaced plant into a few categories, such as load-carrying capability, on-peak energy, and off-peak energy. Each alternative is credited with the benefits it provides: an on-peak solar generator receives credit for its load-carrying capability and for its on-peak energy, but is not barred from competing with a combined cycle unit due to its lack of off-peak generation.

If a particular type of deferrable plant offers some other distinct benefits, such as stability (due to its location), that benefit can similarly be incorporated in the evaluation and pricing of alternatives. If location within the Los Angeles load center is worth $20/kW-yr in stability benefits, that benefit might be most economically provided by urban battery storage, automatic operation of customer emergency generation, or a load-shedding cooperative. The energy and capacity benefits of the deferred plant might be replaced by other sources, including out-of-basin renewables. There is no need to require one particular alternative to replace all benefits of a utility plant.

Most utility plants provide a range of benefits, which may include particular response times, cold-start capabilities, spinning reserve, direct service of particular loads, support of certain transmission lines (which are configured to reflect the location of existing utility plants), a particular level of reliability, specific level of flexibility in maintenance requirements, and a particular energy-production profile. If each alternative (whether that is another utility-owned plant, a QF, a wholesale purchase, or an efficiency measure) were required to match all of those benefits, it is unlikely that any alternatives could ever be found acceptable, and the CEC would have to approve any power plant the utility proposed. This is clearly an unnecessary and inefficient criterion.

Table 1: Estimate of Air Pollution Externality Values Within SCAQMD

1987 $/ton

	Staff			
Pollutant	Highest SCAQMD Value	Levelized Value	IEP	Recommended
	[1]	[2]	[3]	
NOx	$62,500	$87,500	$24,500	$87,500
SOx	$25,000	$35,000	$18,300	$35,000
PM10	$29,300	$41,020	NA	$41,020
ROG	$25,000	$35,000	$17,600	$35,000
CO	$543	$760	NA	$760

Notes:

[1]: Staff Issue Paper #3R

[2]: [1] X 1.404, from "Staff's Procedure for the Calculation of the Valuation of Emissions," 3/7/90

[3]: Testimony of Schillberg and Marcus, 2/21/90

Table 2: Estimates of Air Pollution Externality Values in California, Outside SCAQMD

1987 $/ton

Pollutant	IEP [1]	NSPS [2]	Recommended
NOx	$18,800	$1,200	$18,800
SOx	$1,800	$3,600	$3,600
PM10	$9,000	$9,000	$9,000
ROG	$1,130	NA	$1,130
CO	NA	NA	NA

Notes:

[1] Testimony of Schillberg and Marcus, 2/21/90

[2] Staff Issue Paper #3R

Table 3: Estimates of Air Pollution Externality Values for Out-of-State Generation

1987 $/ton

Pollutant	Staff NSPS [1]	Staff Retrofit [2]	IEP [3]	Recommended
NOx	$1,200	$2,000	$2,700	$2,350
SOx	$3,600	$4,000	$1,000	$4,000
PM10	$9,000	NA	NA	$9,000
ROG	NA	NA	$665	$665

Notes:

[1], [2] Staff Issue Paper #3R

[3] Testimony of Schillberg and Marcus, 2/21/90