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STATE OF ILLINOIS

ILLINOIS COMMERCE COMMISSION

PROCEEDING TO ADOPT A LEAST COST ELECTRIC ENERGY PLAN FOR COMMONWEALTH EDISON COMPANY

ICC DOCKET NO. 90-0038

DIRECT TESTIMONY OF PAUL CHERNICK
PLC, INC.

ON BEHALF OF THE CITY OF CHICAGO

MAY 25, 1990

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TESTIMONY

A P P E N D I X

1. INTRODUCTION AND QUALIFICATIONS

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, 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 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 included, among other things: the need for 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 Part 1.

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

A: Yes. I have testified approximately seventy 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 Vermont Public Service Board, 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 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, 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 testified previously before this Commission?

A: Yes. I testified in Docket 82-0026 regarding the nuclear construction program of Commonwealth Edison.

Q: Have you been involved in least-cost utility resource planning?

A: Yes. I have been involved in utility planning issues since 1978, including load forecasting, the economic evaluation of proposed and existing power plants, and the establishment of rates for qualifying facilities. Most recently, I have been a consultant to the following organizations: various energy conservation design collaboratives in New England, New York, and Maryland; the Conservation Law Foundation's (CLF's) regarding its conservation design project in Jamaica and interventions in a number of New England rulemaking and adjudicatory proceedings; the Boston Gas Company on avoided costs and conservation program design; and several parties regarding incorporation of externalities in utility planning and resource acquisition.

Q: Have you authored any publications on utility planning and 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: What is the purpose of this testimony?

A: The purpose of this testimony is to review the Least-Cost Plan (the Plan) of Commonwealth Edison (CECo or Edison). Page references in this testimony are to the Plan and its Appendices, except as noted. My review specifically concentrates on CECo's treatment of Demand Side Management (DSM), the role of DSM in CECo's plan, and suggestions for improvements in CECo's approaches.

Q: On whose behalf are you testifying in this proceeding?

A: The City of Chicago.

2. PROBLEMS IN CECO'S APPROACH TO PLANNING

2.1 Basic Approach to DSM Planning

Q: What basic problems have you identified in CECo's approach to DSM planning?

A: Most fundamentally, CECo does not treat DSM as a resource comparable to other resources which it must identify, study, and schedule for implementation when they are likely to be cost-effective. This shows up in the Plan as a very limited view of capability-building to provide DSM resources and an understatement of the future role of DSM in meeting resource needs and reducing costs.

In general, CECo appears to view DSM as an optional activity, like acquiring art for its corporate offices, in which it can dabble at its leisure. CECo does not approach DSM as part of its fundamental responsibility to its customers to control costs.

2.1.1 The role of future DSM

Q: How does CECo understate the role of DSM in its Integrated Resource Planning?

A: CECo understates the role of DSM in a number of ways. As I will discuss below, CECo's analysis is poorly organized and is unnecessarily pessimistic about DSM. Consequently, CECo identifies much less cost-effective DSM potential than is likely to exist. In fact, Edison even ignores many DSM programs which its own analysis indicates would be cost-effective in projecting the contribution of DSM to its capacity needs.

This inadequate treatment is illustrated well by Edison's twenty-year projection of capacity sources for base and high-growth forecasts on page IV-10 of its Least Cost Plan. The supply area on each graph appears to be CECo's projection of the mix of supply additions which will be cost-effective to add at various times in the next 20 years. However, the DSM area on each graph is not a <u>best</u> estimate of the amount of cost-effective DSM CECo <u>could</u> have in place by each year on the graph. On the demand side, CECo includes only an extrapolation of the effects of its three proposed pilot programs, even though CECo identifies another twelve programs which analysis shows to be currently cost-effective under the societal test. Eight of these DSM programs also pass CECo's utility revenue requirement cost-effectiveness test. (See pages IV.C-56 to 61 of the Least Cost Plan) However, CECo does not even include the estimated effects of these programs in its integrated resource plan.

CECo also does not make any attempt to determine which of the programs that it does not believe are cost-effective now would be cost-effective starting at a later date due to higher future avoided costs. CECo projects significant increases in its avoided costs over time. The projected avoided energy costs provided on pp. IV.C-37 and IV.C-38 of its Least Cost Plan rise considerably faster than inflation.

As shown on page IV.C-39, CECo projects no avoided generation capacity until 1999, but then expects the capacity value to be $82-86/kW in 1990$. However, CECo has not analyzed DSM programs and determined for each of them when they are likely to be cost-effective. Finally, CECo has not determined whether the DSM measures listed on pages IV.C-56 to 61, or other DSM programs, would be economical if they could displace (for example) the combustion turbine plant planned for 1999 in Edison's base case, or the compressed air energy storage plant planned for 1999 in its high load growth case, or the high-cost energy CECo expects by the end of the century. In short, in addition to ignoring programs which analysis shows to be cost-effective even at today's avoided costs, Edison has also ignored other DSM programs which will be cost-effective later in the decade.

Q: Is this treatment of DSM consistent with CECo's treatment of supply options?

A: No. The figures on page VI-10 show a number of new combustion turbines (CTs), compressed air energy storage (CAES) units, combined cycle (CC) plants, and coal additions in the 1996-2010 period. CECo does not have firm commitments to add these units at the dates shown on either its high-load forecast graph or its base-case forecast graph. CECo has not determined where each of the units will be sited, nor even whether suitable CAES sites exist. CECo has not selected manufacturers, engineers, and constructors, or secured fuel contracts. Indeed, CECo is not sure that CAES will turn out to be cost-effective and feasible in its service territory. Nonetheless, CECo includes on page VI-10 its most likely supply mix and order of capacity additions, based on what it expects today, without requiring that it know exactly what will be built where, and without requiring any firm commitment to the capacity.

Additionally, CECo includes in its plans supply additions which would not be cost-effective if construction began today. CECo has no need for capacity in the near future, and the energy savings from the intermediate and baseload units are not expected to be great enough to justify bringing them into service in the near future. Nonetheless, CECo forecasts the date at which adding each type of capacity will be cost-effective, and includes that capacity in its plans.

In sum, unlike the supply options, CECo has not projected DSM measures to project what would fit into later plans, or determined when it will need to begin planning these resources. Furthermore, CECo has not even established plans for capturing the DSM opportunities which are cost-effective today. It is difficult to imagine CECo taking the same approach to supply side options; if CECo identified cost-effective capital investments which would improve power plant efficiency, CECo would be expected to undertake those investments as promptly as feasible.

2.1.2 CECo view of capability-building

Q: What problem do you have with CECo's concept of building its capability to provide DSM resources?

A: CECo has a very limited vision of capability-building for DSM. CECo's short-term plan for building capability is limited to implementing three rather modest and specialized pilot programs, and to gathering data from the literature, other utilities, surveys, and pilot programs. As discussed below, this process will not prepare CECo to implement full-scale comprehensive programs to defer the need for new capacity. In addition, this approach is not structured, even in principle, to allow CECo to implement DSM programs as they become cost-effective.

At this point, CECo has not identified when particular DSM programs would be cost-effective. Furthermore, CECo has not analyzed how long it would take to develop the programs, purchase equipment, train personnel, hire contractors, design the marketing, test the approach, put the programs in place, and run them to achieve full feasible penetration.

Q: How does this compare to CECo's approach with respect to the supply side?

A: On the supply side, CECo has not identified any measures which are cost-effective in the near future. For future measures which CECo expects might be cost-effective in the future, it has determined the time period required to find a site, perform detailed design, secure permits and licenses, order equipment, and build the plant. These estimates are laid out in Appendix III-E to Edison's Plan (Supply Side Planning). For example, in the high-growth case, CECo thinks it might want to add a CAES unit as soon as 1999. CECo has determined that planning, licensing, design, and other preconstruction activities for this technology will take two years, and that construction will take 3 years. Hence, CECo has determined that it may need to make a commitment to a CAES unit as early as 1994, if load growth is rapid. Similarly, the high-growth case would require a CT in 1996, for which planning would have to start in 1993.

CECO is clearly aware that, if it waited until (say) 1997 to determine whether it were interested in CAES, it would be too late to do the siting, procurement, and construction to get a CAES unit on line by 1999. CECO is clearly committed to being capable of bringing generation on line as it becomes cost-effective, and thus to start planning and licensing with a sufficient lead time.

For the demand side, CECO has no plans for identifying, designing, and ramping up programs so they can be implemented when they are cost-effective. In stark contrast to the supply side, CECo has failed to plan for DSM additions as needed. Hence, it is perfectly possible that there are good programs in CECo's list for which it could achieve significant savings by 1999, avoiding the need for new capacity and displacing expensive fuels, which it will not be able to fully exploit by 1999 unless it starts developing and testing them in 1991 or 1992. CECo has not looked for such programs, and hence cannot possibly be preparing to implement them. Additionally, there are other programs which are currently cost-effective for which Edison has failed to build specific capability.

Q: How should CECo be building capability?

A: First, CECo should identify all programs which analysis shows to be cost-effective either immediately or later in the planning period when avoided cost rises.

Second, CECo should be testing all currently cost-effective programs with large-scale efforts, as soon as feasible, and cost-effective programs should be fully implemented as soon as feasible. A special effort should be made to scale up lost-opportunity programs quickly, since their potential savings are not deferrable.

Third, CECo should identify all programs which would be cost-effective in the planning horizon, and determine when it will have to start implementing test programs to ramp up the programs to full capability by the time they are needed. "Need," in this context, refers to the sum of capacity and energy savings, including line losses, transmission and distribution savings, and externalities (e.g., environmental benefits). In particular, CECo should be determining how far in advance it would need to have programs scaled up in order to allow CECo to enter into all off-system sales which would reduce revenue requirements.

Thus, for each of the programs listed on pages IV.C-56 to 61, and other potentially cost-effective DSM programs, CECo should determine what steps it would have to take at what time to capture the potential from that program when it is cost-effective.

2.2 Evaluation of DSM

Q: What problems have you identified in CECo's evaluation of DSM?

A: There are problems in the screening process, the treatment of off-system sales, the exclusion of externalities, the comparison of costs over time, and the reproducibility of results. I will return in a subsequent section to the subject of valuing environmental and other externalities. I will discuss the other four issues in turn.

2.2.1 Central Screening Process

Q: What screening test does CECo use in its evaluation of DSM programs?

A: This is not clear. CECo computes results of various sorts for the societal test, the utility revenue requirements test, and the non-participants' test.[1] However, it is not clear how

[1]All the tests were run both with and without T&D capacity credits. For most programs, it is far from clear why this would be necessary, since load reductions will provide T&D savings. The load-shifting programs should be run without T&D benefits, and even with a distribution penalty, to reflect the rebound of load at the end of the control period.

CECo used these tests in determining what it considered to be a beneficial program.

Q: What test should CECo have used in screening programs?

A: For screening measures against their direct costs and for screening programs against their total costs (direct, administrative, and monitoring), CECo should have used the societal test, including all customer benefits, the marginal value of other regulated utilities affected by the program (e.g., water, gas), and externalities. This test reflects the value of the program to CECo, its customers, and the general public interest. Any measure which passes the societal screening is "good," and CECo should attempt to realize the potential of all such measures.

Q: What role should the utility revenue requirements test play?

A: Once CECo has committed to implementing a program because it passes the societal cost test, CECo may have several options for how to deliver the program and how to recover its cost. Some of these options will charge more of the cost to the participants or otherwise reduce the utility's costs, thereby increasing the revenue-requirements benefits of the program. To the extent that program design can improve the present value of the revenue requirements test (e.g., reduce revenue requirements) while not significantly reducing the present value of the societal benefits, the utility revenue requirements test can be a useful guide to improving program design.[2]

Q: Why should the utility revenue requirements test be given only a secondary role, compared to the societal test?

A: The societal test reflects the total benefits and costs, while the utility test reflects only the portion of the costs and benefits which flow through the utility. On the supply side, for such issues as reliability, utilities are routinely expected to include the benefits and costs to their customers of issues that cannot be reflected in utility revenue requirements analysis (e.g., reduced service quality) in evaluating the cost-effectiveness of investments. As one illustration of this point, it is difficult to imagine a utility arguing that reduced tree-trimming is cost-effective because it cuts revenue requirements, unless it believes that the cost to customers of increased frequency of outages is less than the benefit from the cost reduction.

Q: What role should the non-participants' test play?

A: The non-participants' test is not very meaningful on a measure-by-measure or program-by-program basis. The non-participants' test is an equity measure of the effect on other customers of the operation of a particular utility DSM program

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[2]CECo apparently changed the utility revenue requirements test when it computed cost/benefit ratios, by adding lost revenues to the cost. I have therefore concentrated on the present value tests, rather than CECo's ratio tests. In any case, the net present value benefit is more important than the ratio of benefits to costs.

or measure. However, individual measures and programs cannot really be thought of as equitable or inequitable in isolation. Rather, the costs and benefits of the entire portfolio of conservation programs either produces an equitable outcome, or it does not.

Analysis of the effect on non-participants of each individual DSM program is analogous to analyzing the impact of each supply related investment on non-participants. If a distribution line or power plant is needed to provide reliable and cost-effective service to a fast-growing area, the fact that the addition may increase rates to slow-growing areas is not considered a valid objection to construction of the facilities. Similarly, utilities routinely add plant that raises rates to one temporal group of customers (e.g., customers in 1990) in order to lower cost to another group (e.g., customers in 2010), so long as the aggregate effect is beneficial.

The effect on equity of each program will depend on (1) the cost recovery from that program,[3] (2) whether the participants in this program are already participating in other programs, and (3) how the bills of members of various classes and sub-classes are affected by the program.

Once an entire DSM portfolio is designed, it is relevant to ask whether the effects are equitable overall. In making

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[3]For example, the equity effects will depend on how the costs are recovered from various rate classes.

this determination, the impact of supply investments on particular groups of customers should also be considered. If there are equity problems, they can be addressed by changing cost recovery patterns, by increasing the penetration of programs to groups which would otherwise face higher bills, and possibly by changing the timing of program implementation.

2.2.2 Off-system sales

Q: Has CECo incorporated off-system sales in the benefits from DSM?

A: No. CECo appears to assume that conserved energy would be used to back down CECo plants, rather than freeing up either energy or capacity for sale. If CECo makes profitable sales, it will decrease retail revenue requirements. Reflection of such sales appears to be contemplated in the Least-Cost Energy Planning rules, Section 440.310(a)(3).

Q: Is there likely to be a market for CECo power?

A: Yes. According to Mr. Hill's testimony, Edison has executed a contract to sell 195 MW of firm power to WEPCO by 1994. Other long-term sales opportunities appear to exist in Wisconsin, where various utilities report a need for 1700 MW by 1996. For example, WEPCO is planning 220 MW of combined cycle generation, and may also need to replace the 400 MW Port Washington coal plant if the EPA "WEPCO" ruling stands. Additionally, a municipal utility in Wisconsin is considering the addition of 20 MW of coal capacity. Indiana utilities, including Indianapolis Power and Light and Public Service of Indiana, also have recently been seeking to purchase power.

Q: Are sales to these utilities likely to be profitable?

A: Some profitable sales are likely to be profitable, especially if Edison could execute long-term contracts. In general, long-term sales are priced higher than short-term sales, since the long-term sale allows the purchaser to avoid adding capacity.

If Edison had baseload capacity available for 15 years or more, it could sell that capacity for a higher total price than it gets for energy alone on a spot basis, or capacity on a short-term basis, such as a month or a year.

Q: Why can CECo not sell power long-term without DSM?

A: Given Edison's demand and supply forecasts, Edison cannot currently commit to long-term sales of baseload and/or peaking capacity, over periods of 15-25 years. Edison anticipates a need for additional capacity (stated as a range for high and base load growth forecasts, from Exhibit III-9 of Edison's Least Cost Plan) that follows this framework:

- new peaking capacity in 1996-99,
- new intermediate capacity (CAES or combined cycle) in 1999-2000, and
- new baseload capacity in 2003-2008.

Hence, for a utility seeking capacity starting in 1994, Edison can only offer to sell for 2-5 years without committing to building replacement capacity. If Edison is willing to build (or buy) additional peaking capacity, it could sell intermediate capacity (for example, Collins) for 6 years. Similarly, adding peaking and intermediate capacity might allow Edison to sell base capacity for 9-14 years. Moderating Edison's load growth with DSM would allow for longer sales, without the need to add capacity.

Q: Does CECo include off-systems sales in supply-planning decisions?

A: CECo should include off-system sales opportunities in all supply-side decisions which would affect such sales. Specifically, the Plan identifies lost off-system sales from its coal plants as one of the costs of mothballing its coal plants.[4] Any resource which frees up energy and/or capacity for profitable sales is beneficial to the Company, regardless of whether that resource is conservation or an increase in net capacity at a nuclear unit.

Q: Have you examined whether DSM could reduce retail loads enough after 1995 to allow Edison to sell 195 MW or more under a long-term contract, such as 20 years?

A: Yes. The analysis in Section 3 of this testimony indicates that Edison should be able to achieve reductions of a much larger magnitude.

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[4] See p. III-13, last dot-point: " . . . off-system sales which are beneficial to customers, as revenue requirements are reduced". Edison did not analyze whether addition of DSM resources could make mothballing cost-effective.

2.2.3 Comparison of costs over time

Q: What problems have you identified in CECo's treatment of the stream of costs and benefits of DSM programs over time?

A: There are two timing problems in the DSMPRO analyses shown on pages IV.C-63 to 151 of Appendix IV to the Least Cost Plan. First, CECo limits the analysis to 20 years (1990-2009), even for programs which are expected to produce benefits for up to 40 years. Thus, not all of the benefits of investments in 1990 are included in the comparisons of costs and benefits.

Second, and more importantly, CECo includes costs of program implementation for years after 1990, but includes benefits only until 2009. Thus, for 1991 investments, only 19 years of benefits are included in the analysis; for 2009 investments, only one year of benefits is included.

Thus, for the year 2009, Edison assumes that various conservation measures are installed and the costs of these measures are reflected in the analysis. However, Edison does not reflect the fact that these measures will provide the benefits of saving energy in the year 2010 and subsequent years. This is a completely incorrect and inappropriate approach to comparing costs and benefits. For the costs included in the analysis, all benefits should also be included.

Q: Is this approach equivalent to the way CECo evaluates supply options?

A: I do not believe so. In evaluating the construction of a series of coal plants, CECo would compare the costs of <u>each</u> coal plant over its life to the benefits over its life. CECo would not compute the benefits of the series of plants over a short period of time, and subtract the present value of the capital and operating costs of the plants over the same period.

2.2.4 Irreproducibility of results

Q: Have you found problems with the reproducibility of CECo's results?

A: Yes. I encountered problems in reviewing the DSMPRO results. The evaluation of potential DSM programs is summarized in Tables IV.C.4-1 to 6 on pages IV.C-56 to IV.C-62 of Appendix IV. These results are taken from the printouts on pages IV.C-63 to 148. For example, for the Residential Existing Building Retrofit program (the seventh program on p. IV.C-57), the benefit/cost ratio and unit costs are rounded versions of numbers on page IV.C-70. I will use that program as an example of the difficulties in reproducing CECo's results.

On page IV.C-70, the top two rows of numbers are the projected cumulative numbers of customers using the conservation measures, with and without the Edison DSM program.[5] The first problem involves converting these penetration or saturation rates into the number of "customers" (i.e., participants) in the first column. The number of space-heating customers is about equal to the 2,890,000 residential customers on p. II-A-16 for 1990, times the space-heating saturation of 7.06% for 1990 on page II-A-62, or about 204,000. With the program, CECo expects a saturation of 13.9% in 1990 for the existing building retrofits, which would imply 28,400 participants. However, CECo reports only 14,485 participants in 1990. Similarly, I have not been able to reproduce the "customer" numbers for other years, or by assuming that the "customer" column refers to the difference between the baseline and program saturation.

Furthermore, on page IV-43, CECo shows an incremental cost for the existing building retrofit of $2300, and page IV-44 shows an incentive of 75% of the cost. Therefore, the "incentive payments" column for 1990 should be 14,485 participants * $2300 * 75%, or $24,986,625, but the incentive column reads $28,995,576. If that is an error, and it should read $25 million, then the costs are overstated by $4 million, just for 1990. Since this program, as CECo evaluated it,

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[5]These lines indicate that CECo is expecting, even without the program and for each year from 1990 to 2009, that 1-2% of residential space-heating customers would spend $2,300 and reduce their loads by 4,881 kWh/year; that is the description of the existing building program on page IV.C-43.

flunks the social test by less than $3 million, this one correction would cause it to pass.

Similarly, the "customer cost" column should be the remaining 25% of the incremental cost. Repeating the same computation gives 14,485 * $2300 * 25% = $8,328,875, not the $13,374,338 listed for 1990.[6] Again, this one correction would cause the program to pass.

Finally, based on the definitions of the tests on page IV.C-18, the data in this table does not yield the present values (PV) for the various cost/benefit tests at the bottom of the table. For example, the societal test is defined on page VI.C-198 as the present value of energy and capacity savings, net of incremental equipment costs and program administration costs (all expressed in present-value terms). My calculations indicate that the present value, on the line labelled "Societal Test: C-Prime" on page IV.C-70, does not follow from the societal test definition based on the data provided in the table.

Q: How serious are the problems you have experienced in attempting to replicate CECo's results?

A: If CECo's analysis was otherwise properly structured, if CECO had compared the full costs and benefits of its programs, and

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[6]Oddly enough, the ratio between the reported customer cost and the cost I calculated is quite different from the difference between the reported and calculated incentive values. Thus, it appears that CECo used different customer numbers to drive the incentive and customer-cost computations.

if CECo was actually committed to implementing all of the programs which it identified as being cost-effective, the apparent inconsistencies in the DSMPRO output would be very serious, indeed. However, since CECo has not properly considered its DSM alternatives, and has not committed to implementing programs which it found to be cost-effective, it is not clear that even massive changes in the DSMPRO output would have made any differences in CECo's proposal in this case.

In the future, CECo should fully document its cost-effectiveness analyses. To reduce the bulk of the Plan, CECo could omit the conservation analyses which exclude T&D credits.

2.3 Program design philosophy

Q: What do you mean by "program design philosophy"?

A: I refer here to the general approach taken to identifying desirable measures and packaging them into programs, and to the central concepts guiding program design.

Q: On what points is CECo's program design philosophy deficient?

A: First, it is not easy to identify CECo's philosophy. CECo provides very little rationale for its approach.

Even after extensive discovery, in many cases it is difficult to determine how CECo came up with the results reported in the Plan and the Appendices. Even where it is possible to determine <u>what</u> CECo did, it is not always clear <u>why</u> CECo made those choices, or even whether the choices were made by CECo or its consultants. That said, there are several areas in which CECo's approach is deficient or inappropriate. These include

- the role of objectives,
- comprehensiveness,
- market-oriented design,
- capability-building,
- service delivery, and
- cost sharing.

2.3.1 Objectives

Q: How does CECo use objectives in screening DSM options?

A: CECo uses two sets of objectives. First, CECo applies a set of load-shape objectives, and screens out some options. Second, CECo evaluates options against the societal, utility, and non-participant tests.

Q: What is wrong with CECO's use of objectives?

A: There are problems in CECo's application of both sets of objectives. With regard to the various cost-effectiveness tests, I have already described the problem with CECo's failure to focus on the societal test for screening options and its elimination of many programs which passed both the societal test and the utility revenue requirements test. Edison even eliminated four programs which passed the nonparticipants test, as well as the societal test and utility revenue test.

With regard to the screening of options based on load shape, CECo's approach is inappropriate. CECo selects arbitrary (and undocumented) weights for each of a half-dozen load-shape effects, and then multiplies those weights times rough measures of each option's contribution to achieving those effects. This approach assumes that the desirability of a load-shape change can be determined without any knowledge of the cost of the change, and only a rough approximation of the benefit.

Depending on the cost and benefit of each option, any of the load-shape changes listed on page IV.B-3 may be desirable or undesirable from a societal perspective. For example, if a value-filling measure is inexpensive to implement, displaces expensive alternatives (e.g., fossil fuels in some industrial processes), and can be terminated before new baseload capacity is required or existing baseload capacity becomes valuable for resale, it may be very beneficial. If the measure is expensive, has little social benefits, and will increase system costs in the long term, it may be very undesirable. The concept of "valley-filling" is not particularly useful in screening programs or measures.

Q: Are there any of CECo's objective weights which you consider to be particularly inappropriate?

A: Yes. CECo gives no value to winter conservation. This understates the value of programs oriented toward reducing space-heating use and other winter-dominant uses (e.g., streetlighting). Such conservation reduces fuel costs, increases potential for off-system sales (especially of valuable base-load capacity), and defers the need for new expensive intermediate and base-load plants.

Q: Should load-shape objectives have any role in least-cost planning?

A: Not explicitly, for most purposes. To the extent that program designers know that certain kinds of load changes are particularly valuable, they can concentrate on identifying measures which achieve those types of changes. The Commission may also wish to impose stricter standards for the justification of promotional programs (e.g., valley filling and load growth) than for conservation. However, for screening measures and programs, only the costs and benefits of each option are relevant.[7]

2.3.2 Market-Oriented Design

Q: What do you mean by "market-oriented" program design?

A: A market-oriented DSM design process starts with a segment of the market, and designs a program to achieve all cost-effective conservation within that market. The cost-effectiveness of the resulting program is also determined at the level of the entire package. This can be thought of as a "Top-Down" design process, as opposed to CECo's "Bottom-Up" process of enumerating and evaluating each technology (or end-use, or measure) individually.[8]

Q: What types of segments might be useful for CECo's analysis?

A: The segments should be defined in terms of the type of delivery mechanisms which would be appropriate. Thus, small customers should be separated from large customers, lost opportunities from discretionary programs, customer-driven

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[7]The benefits per annual kWh saved from a conservation measure will depend on the shape of the load effects, as well as the number of years the measure will persist.

[8]CECo deviates from this approach to a more market-oriented approach in a few cases, such as the New Residential package.

choices from those usually made by contractors, etc. For the residential class, useful segments might include

- heating retrofits,
- water-heating retrofits (possibly including heat pumps),
- new-appliance efficiency, including choice and water-heater installation measures (wraps, pipe insulation, end-use reductions),
- new-building efficiency, and
- lighting, probably broken into direct retrofit, demonstration programs, and retail market shifting.

Many of these markets would have separate requirements for owner-occupied and rental housing, and for low-income and other customers, since the barriers differ among these groups. For the commercial, institutional, and governmental customers, there may be similar differences in requirements for delivery mechanisms and incentive levels for large and small customers, and for business and non-profit customers. Appropriate segments might include

- comprehensive retrofit, including lighting, HVAC, building shell, window treatments, refrigeration, and motors (e.g., elevators);
- new construction, renovation, and rehabilitation; and
- routine equipment replacement (e.g., chillers).

For industrial customers, the categories would be similar to those for commercial customers. However, the "new construction" category should probably also include major equipment and process changes (analogous to the commercial rehab, but not necessarily affecting the spacial layout). In addition, the retrofit program must allow for customer-originated improvements in equipment and processes.

Depending on how the segments are defined (e.g., whether the low-income residential retrofit market is counted as a subset of the residential retrofit, or as a separate market), this approach would focus on roughly one or two dozen packages, rather than many dozens of technologies and measures.

2.3.3 Direct delivery of services

Q: Do you have a general criticism of CECo's approach to delivering DSM services to customers?

A: Yes. In general, CECo appears to focus on such incentives as rebates and loans to encourage customers to implement conservation measures.[9] However, as discussed in Appendix Part 2 to this testimony, there are many barriers to customer action which will not be efficiently addressed by rebates. Uncertainty, lack of knowledge, split incentives, lack of time for exploring options, limited retail availability, and aversion to dealing with contractors will not be overcome by rebates alone. A customer who has not found the time to seek

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[9] I assume that CECo is expecting to install much of the load-control equipment directly.

out compact fluorescent bulbs is not likely to find the time to seek out the bulbs and fill out rebate forms.

Q: How should CECo address these barriers?

A: For many measures, direct design and/or installation services must be offered.[10] For example, a residential heating retrofit program should provide for an audit, selection of cost-effective measures, and installation, with as little demand on customer time as possible. To the extent that CECo designs, arranges, finances, oversees, and warranties the work, the customer avoids most of the hassle factors which complicate any major home improvement. This is particularly important for residential and small commercial customers, and may also be significant for larger customers in some segments.

In other cases, CECo may need to change the way that products and services are delivered in its service territory. Offering incentives to appliance dealers, heating contractors, plumbers (for water-heater replacement), and lighting dealers may be more effective than offering rebates to customers. Rebates may be appropriate as part of some programs, but they are often only part of the best solution, and are sometimes totally inappropriate.

Q: Can you cite a specific example of the problem caused by CECo's failure to address market barriers?

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[10]The actual delivery would usually be through a contractor, rather than by CECo employees.

A: Yes. On page IV.B-12 of the Main Report of its Plan, CECo indicates that it rejected a residential lighting program because of "low current availability and market potential."[11] The "low current availability" of efficient lighting in retail outlets is probably a very important barrier to residential adoption of these highly cost-effective technologies. Rather than throwing up its hands, CECo should be designing and implementing programs to get compact fluorescents into every residential customer's home (through direct installation, its light-bulb replacement service, and/or mail order) and to make additional equipment available in retail outlets (especially supermarkets, discount department stores, and other visible retailers, as opposed to lighting specialty stores) through rebates tied to cooperative advertising, dealer incentives, and customer rebates.

2.3.4 Comprehensiveness

Q: What do you mean by "comprehensiveness"?

A: I refer here primarily to achieving all cost-effective efficiency improvements for each customer involved in a

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[11] I do not know what CECo may have meant by "market potential". The market potential for high-efficiency lighting is not particularly low. A very small amount of compact fluorescents have been installed in residences in Edison's service territory. Replacement of 5 incandescents per household with compact fluorescents at an average saving of 50 watts per bulb and 1000 hours annual use would save 250 kWh per household.

program. In addition, CECo's programs should be comprehensive in addressing all customers and all market segments.

Q: In what ways does CECo overlook comprehensiveness?

A: CECO appears to examine individual measures, or small bundles, rather than the total opportunities for improving the efficiency of a customer. For example, the residential "water heater wrap and pipe insulation" includes only those two measures, for which CECo proposes to give the customer a $7.50 rebate to install $15 worth of materials. CECo estimates that delivering the $7.50 rebate, but no other services, would cost $100. For roughly the same total cost, several New England utilities have proposed and/or instituted programs which provide for direct installation of the tank and pipe insulation, plus high-efficiency showerheads, faucet aerators, shut-off valves, and compact fluorescent lamps, and tuning or maintenance of refrigerators and/or air conditioners. The comprehensive approach delivers all the efficiency services which are economical as a package; the single cost of getting an installer to the house is spread across a large number of measures, and no potential cost-effective savings are left "on the table".

As another example, CECo's proposed residential water-heater control program appears to be completely isolated from other water-heating measures, let alone measures for other end-uses. Before a control on an electric water heater is installed, it should be determined whether that control is more beneficial than other alternatives, such as installing a water-heating heat pump, improving efficiency, or converting the customer to a gas water heater. Even if CECo finds that controlling the water heater is cost-effective, all the efficiency improvements are still likely to be cost-effective; while CECo has an installer on the premises, it should ensure that the water heater and pipes are wrapped, and that efficient showerheads and faucet aerators are installed. With little additional cost, the same installer can screw in a few compact fluorescent light bulbs.

Q: Can you cite an example of CECo's lack of comprehensiveness causing particular problems in its program designs?

A: Yes. CECo's rejection of commercial lighting programs appears to be the result of including only lamp and ballast technologies and setting very low efficiency targets, which produce very small savings. These small savings are out-weighed by the program's administrative costs. A comprehensive program, which included additional measures (reflectors, occupancy controls, daylighting controls) and required the highest cost-effective efficiency level for lamps and ballasts, would have higher savings. Since virtually all analyses of urban utility conservation programs find that commercial lighting is one of the largest and most cost-effective areas for energy-efficiency improvements, CECo should have been surprised by the failure of its commercial lighting program to pass the societal and utility tests, and revised its program design accordingly.

2.3.5 Learning by doing

Q: Does CECo have a realistic view of capability-building?

A: No. The three small and limited pilots CECo has proposed will not build much capability. In particular, the residential and commercial programs are load-control programs, which will probably not teach CECo much about analyzing its customers' energy use patterns, delivering comprehensive retrofits, affecting design decisions, intervening in the renovation cycle, or changing purchasing patterns. The industrial program will address the issue of changing purchasing patterns for that class, but not the other issues. These three programs will not contribute greatly to CECo's ability to design and deliver other cost-effective DSM programs.

In general, CECo should think less about small-scale pilots or the delivery of an isolated measure, and orient its capability-building more towards large-scale programs fully addressing a market segment. Only large-scale programs will demonstrate the costs and benefits of full-scale implementation, and only comprehensive programs will teach CECo how to achieve all cost-effective conservation.

Q: Does CECo demonstrate a clear vision of how fast it needs to build capability for delivering DSM?

A: No. CECo appears to view DSM as being of significant interest only in the remote future, if ever. Specifically, CECo does not appear to understand that it will need some capability to deliver DSM prior to the date at which it first needs to add capacity.

Q: Why would CECo need DSM delivery capability prior to the data at which it needs capacity?

A: There are several reasons for acquiring early DSM-delivery capability. First, for efficiency opportunities which will be lost (e.g., new construction, rehabilitation, renovation, expansion, routine equipment and appliance replacement, and industrial process modifications), CECo must be able to realize all cost-effective opportunities as they occur; a building constructed in 1994 will not be rebuilt in 1999, if CECo needs capacity.

Second, many DSM programs will be less expensive than operating CECo's existing marginal power supplies, including line losses and T&D requirements; CECo can reduce costs long before it avoids generating capacity.

Third, if CECo is to avoid 400 MW of capacity in 1999 and another 440 MW in 2000 (the amounts of new capacity projected to be added in the base forecast) by implementing DSM, it will need to implement some significant amount of DSM prior to 1999. Going from virtually zero DSM savings in 1998 to saving over 840 MW in the year 2000 is probably impossible.

Fourth, CECo will have to convince itself and the Commission that its DSM programs will produce real savings before it can avoid capacity additions. In order to avoid adding a CT in 1999, CECo would have to decide in 1996 whether to order the equipment and pursue licensing.[12] Thus, by 1996, CECo would have to have run enough large-scale programs to demonstrate that significant demand reductions would be achievable by 1999. In order to allow time for implementation, evaluation, and review those programs might have to start as early as 1991.

Fifth, implementation of DSM prior to CECo's need to add capacity can allow CECo to sell capacity off-system for extended periods of time, reducing retail revenue requirements. The same concerns about ramp-up and demonstration expressed for capacity avoidance in the preceding two paragraphs apply as well to the decision to sell off-system.

Hence, if CECo is to minimize costs to its ratepayers and to society, it will have to build real DSM delivery capability rapidly, rather than waiting until a capacity addition is imminent.

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[12]The lead time may be longer if turbine manufacturers are operating at or near capacity. The lead time for the 1999 CAES unit proposed for the high-growth case would be five years, pushing the decision date back to 1994.

2.3.6 Participant cost-sharing

Q: How does CECo determine how much of the cost of a conservation measure it will bear?

A: In general, CECo appears to have used a complex computer model to project program penetration at different incentive levels. However, the specific basis for selecting the rebate levels in Tables IV.C-1 to 3 are not documented.

Q: How should CECo determine the sharing of costs between participants and the utility's ratepayers as a whole?

A: CECo should start by identifying an efficient mechanism for delivering services in each market. Given that mechanism, and the nature of the market barriers in each market, CECo should select a funding level which will achieve essentially all of the achievable potential by the time that it is cost-effective, and which will not significantly increase the costs of program delivery. CECo should not arbitrarily refuse to pay for the full incremental cost of efficiency improvements, if that is the most effective and efficient means of securing those improvements.

To the extent that some program costs are recovered from participants, the participants should be given the option of having the recovery flow through their bills. This may be very important for some customers (such as government agencies) which would have to secure numerous and complicated approvals to put up cash or to sign a loan agreement. It may also be important for customers with cash constraints, and may overcome a psychological barrier even for those customers who are not cash-constrained.

3. POTENTIAL FOR COST-EFFECTIVE CONSERVATION

3.1 Studies of Potential

Q: How large is the potential for cost-effective electricity conservation in CECo's service territory?

A: No precise answer to that question is currently available. The amount of cost-effective conservation depends on the social avoided cost (including externalities and risk reduction), on the composition of current and future stocks of buildings and equipment, on the evolution of efficient technologies, and other factors. No comprehensive study of conservation potential has been performed for CECo. Since the best way to determine the potential for most markets is to implement an aggressive program and measure the response, it is not clear that a comprehensive study would be useful.[13]

We can get a rough sense of the potential by examining the results of studies performed in other states. It should be noted that these studies generally reflect technology options from several years ago: the cost of efficiency improvements have fallen, and potential has increased. The

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[13]Improvements in technology and in delivery strategies will also continually increase the achievable potential, so any study of potential can be "comprehensive" only for a short period of time. On the supply side, utilities generally commit to investing in technologies even though they do not know exactly what heat rate each unit will achieve or exactly how many sites may be available in the service territory. So long as an initial unit appears to be cost-effective, and a site has been identified, the utility can start using a new type of resource (e.g., CAES) long before it knows exactly how much it will build or exactly how the units will perform.

values of avoided costs used in these analyses vary, but they generally represent some proxy for new baseload plant construction, without any adjustment for line losses, T&D costs, load factor, or the benefits of reduced risk or avoided externalities.[14] Also, these studies generally do not examine fuel-switching from electricity to direct fuel use, which my work for the Boston Gas Company (see Appendix Part 5) and for the Central Vermont Public Service Corporation collaborative shows a high level of cost-effectiveness, both in terms of direct costs and in terms of total social costs, including externalities.

Chernick, et al. (1989), a study prepared for the Minnesota Department of Public Service, determined that the total cost-effective conservation potential for Minnesota's electric utilities was 52%. We estimated that potential cost-effective efficiency savings were 60% in the residential class, 50% for farms, 60% for commercial customers, and 35% in industry.

Lovins (1986a) estimated a 50% cost-effective potential savings in energy use of the 1984 building and equipment stock in Ontario. In the industrial sector, 70% savings were possible, in the commercial sector 32% savings, and in the residential sector 46% savings.

[14]Except for the PLC, Inc., study, and Lovins's work, these analyses generally ignore avoided line losses and avoided transmission and distribution costs.

Lovins (1986b), a report to the Austin (TX) Electric Utility Department, found that cost-effective efficiency investment by 2005 could reduce annual peak demand by 73%, and energy usage by 72%.

Usibelli, et al., (1983), a study commissioned by DOE, found that technically feasible energy conservation measures costing less than 40 mills (roughly equal to the Northwest Power Planning Council's estimate of avoided supply costs) could reduce residential electricity demand in 2000 by 36.5% in the Pacific Northwest.

Geller, et al., (1986), prepared for Pacific Gas and Electric, examined seven end-uses representing 70% of PG&E's residential electricity consumption. This study found that cost-effective efficiency investment could reduce electric energy needs in 2005 by 25%-44%, depending on the penetration of current and prototype technologies.

Miller, et al., (1989), a study for the New York State Energy Research and Development Authority, estimated that efficiency investments in the 1986 building stock which were cost-effective under their "societal" test would yield total savings of 34%, based on 34% savings in the residential class, 47% in the commercial class and 16% in the industrial class.

Gertner, et al., (1984) limited their scope to retrofit technology and capability for office and retail buildings built before 1983. That study concluded that full implementation of cost-effective measures, with pay-back periods of one to three years, would reduce the electrical usage in those buildings by 36%.

Krause et al., (1988) studied the residential loads of Michigan's two largest utilities, and estimated technical conservation potential from existing and prototype technologies at 42% of usage in 1995 and 56% in 2005. The same study estimated that cost-effective conservation programs (with realistic limits on participation) could achieve energy reductions of 21% in 1995 and 29% in 2005. Technical potential of 19% of 1985 sales was identified for fuel-switching of appliances, excluding space heat.

Overall, it seems reasonable to expect cost-effective energy efficiency potential in the 30-70% range, depending on the level of avoided costs, the time frame used, and other variables. Even excluding the studies by Lovins, who is widely seen as an advocate for DSM, the range of potential is 30-50%.

3.2 Commitments and Plans of Specific Utilities

Q: Which utilities' conservation commitments and plans have you reviewed?

A: I have reviewed the conservation plans of a number of New England utilities, which I have summarized in Table 3.1, and of the major California utilities, summarized in Table 3.2. I will also cite some historical figures for a few other utilities.

Q: Please describe your sources for the figures in Table 3.1.

A: All the figures were obtained from utility testimony or reports, or from EIA data. Other than adding up projections for individual programs, and correcting obvious errors (e.g., kW values which were stated as MW values), the data is from the utilities themselves. The data for CV represents the status of collaborative program design in February 1990; the other data represents specific utility plans or proposals.

Q: Please describe the results of Table 3.1.

A: Table 3.1 summarizes the conservation expenditures and savings for selected New England utilities. The most interesting columns in Table 3.1 are columns [4], [6], [8], and [10]. Column [4] expresses each utility's conservation expenditures as a percentage of its 1987 revenues. This percentage is evenly distributed between 2.4% for UI to 8.2% for CVPS, with most of the values clustered about 4%.

Column [6] shows the average incremental MWh saved annually as a percentage of 1987 sales. The percentage ranges from .5% for UI to 1.9% for CVPS, with an average of 1%.

Column [8] shows the MWh saved in the last year of a utility's conservation program, again as a percentage of 1987 ultimate consumer sales. Since the savings in the last year of the program include the effects of all the conservation measures installed in the course of the program, longer programs will tend to show more impressive results. The percentages range from .8% for MECo to 19.2% for CVPS. MECo's figure is low because it represents the results of only a one-year program. CVPS' savings are significantly higher than those of other utilities; the second highest savings are those of NEES, at 17.7% of 1987 sales at the end of a twenty-year program. It is worth noting that both EUA (8.4%) and WMECo (8.5%) expect to achieve half of NEES's 20-year savings in just five years.

Column [10] shows the energy saved by DSM programs as a percentage of each utility's 1987 peak load. The savings are evenly distributed over a wide range, from a low of 2.2% for MECo to a high of 11.3% for CVPS. Again, program length is a key determinant of effectiveness.

Q: Do any of the New England utilities who have adopted the substantial conservation programs have excess capacity?

A: Yes. Northeast Utilities (the parent of CL&P and WMECO) and United Illuminating have committed to substantial DSM programs despite surplus capacity. For example, CL&P has committed to spend over $600 million on conservation programs and to reduce its peak load by 11.8%.

Q: Please describe Table 3.2.

A: Table 3.2 is a summary of projected 1990-91 conservation expenditures and savings for major California utilities. The utility expenditures and savings were taken from the January 1990 <u>Report of the Statewide Collaborative Program, An Energy Blueprint for California</u>. Utility revenues and sales are from the Energy Information Administration's Financial Statistics of Selected Electric Utilities, 1987.

The table gives figures for three utilities, Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E). The first column represents each utility's spending on conservation programs in 1990 and 1991. The dollar figures are nominal dollars. The Blueprint specifies that the SCE figures assume a 3.5% increase for inflation plus incremental costs. Inflation figures are not given for the other utilities.

Column [2] expresses annual conservation expenditures as a percentage of 1987 ultimate consumer revenues. Column [3] lists the incremental MWh saved in each year. Column [4] expresses those savings as a percentage of 1987 ultimate consumer sales.

Both PG&E and SDG&E have both gas and electricity conservation programs. The Blueprint provided PG&E expenditures specifically for electricity conservation. SDG&E expenditures appeared to include only the costs of the electricity conservation program, and no gas conservation costs, but this was less clear than for PG&E.

Q: What data do you present in table 3.3?

A: Table 3.3 presents past conservation expenditures and savings of selected utilities. All the figures in this table were obtained from Geller and Nadel (1989). All costs are in 1987 dollars.

The first column describes the time period covered by the expenditures. The second column lists the cumulative costs of conservation program over the time period given in column [1]. Column [3] gives the costs incurred in only the last year of the program. Column [4] expresses these costs as a percentage of each utility's 1987 revenues.

Column [5] shows the incremental MWh saved in the last year of the period covered by the expenditures, with the exception of the Central Maine Power (CMP) figures, which are for its program's penultimate year. Column [6] expresses these savings as a percentage of 1987 sales.

Column [7] shows the incremental MW saved in the last year of the period covered by the expenditures, again with the exception of CMP. The CMP figure is for the penultimate year of its program. Column [8] expresses these savings as a percentage of 1987 peak load.

Q: What magnitude of effort would constitute a major DSM effort for a utility the size of CECo?

A: CECo should expect to ramp up to spending a few percent of its annual revenues on conservation, or roughly $200 million a year on DSM. CECo should also be thinking in terms of putting together a plan in the short term (e.g., within a year) which would save 1% of 1987 sales each year, or roughly 700 GWH. Over the first 10 years of the program, CECo should be looking for savings on the order of 7,000 GWH. Subsequent plans may well identify larger amounts of cost-effective DSM, so these targets should be considered as starting points.

4. SUGGESTIONS FOR SHORT-TERM PROGRAM PRIORITIES

Q: As CECo ramps up its capabilities to deliver all cost-effective DSM services, are there any principles which might guide its prioritization of markets and programs?

A: Yes. CECo should

- concentrate on capturing lost opportunities,
- concentrate on markets with naturally low levels of free riders,
- concentrate on programs which are currently cost effective,
- build capability in delivering comprehensive programs to large groups of customers, and
- improve the equity of service delivery.

Q: What markets would represent lost opportunities?

A: This category would include new construction, renovation, rehabilitation, routine replacement of appliances and equipment, and major changes in industrial equipment and processes.

Q: What types of markets would tend to have low levels of free riders?

A: These are markets with low current penetration of efficient technologies. For state-of-the-art equipment, design and systems, most markets appear to have low current penetrations. However, some sectors tend to be particularly slow to adopt even well-known and conventional improvements. These sectors tend to include government and non-profit entities (especially those with severe budget constraints), low income residential customers, and end uses for which the landlord supplies the equipment and the tenant pays the bills.

Q: How might CECo build capability in delivering comprehensive programs to large groups of customers, while concentrating on particular subgroups?

A: Many of the lessons learned in serving one market sector will be useful in reaching other sectors. For example, a lighting and HVAC retrofit program in municipal buildings will involve technologies and physical situations much like those found in many commercial buildings. Similarly, direct delivery of efficient lighting to low-income residentials will involve many techniques which will be applicable to lighting as part of a general residential retrofit program, or one targeted to space- or water-heating customers.

Q: How can CECo improve the equity of service delivery during the ramp-up period?

A: In general, there are groups of customers who are in particular need of DSM services and for whom the bill reductions would be particularly valuable. These customers could not otherwise invest in these measures and therefore have no possibility of being free riders. Other public-interest purposes are often served by assisting these groups. Example of this category would be low-income residentials, governmental bodies, and economically vulnerable industries. Early efficiency assistance to low-income customers is likely to reduce the need for public assistance (including possibly the costs of sheltering additional homeless persons), improve the well-being of disadvantaged individuals, and reduce the extent of CECo's bad debt. Assistance to governmental units (especially those with severe financial constraints such as some school districts) is likely to reduce tax burdens and/or improve public services. Reducing the energy bills of vulnerable industries is likely to retain customers, avoid the need for some rate discounts, avoid the loss of jobs and tax revenues, and reduce the social disruption resulting from layoffs and plant closings.

Q: Are you suggesting that services to these groups be pursued even if they are not cost-effective?

A: No. Some of the benefits listed in the previous answer might properly be quantified and monetized as social and economic externalities. Those external benefits could then be added to the direct avoided costs to compute the total social benefits of each program. Programs with large external benefits will be more desirable than they would have been without them.

However, even if CECo assigns no economic externalities in the cost-benefit analysis, it is still desirable to prioritize cost-effective programs to reach vulnerable and disadvantaged groups first.

Q: Can you provide some examples of the kinds of programs which might be prioritized?

A: Yes. For low-income residential, the most important opportunity might be a door-to-door delivery program emphasizing high-efficiency lighting. While they are in the house, the delivery staff can also offer minor tune-up and maintenance services on room air conditioners and refrigerators, and attach information to the refrigerator (which is probably owned by the landlord) on landlord-oriented efficient appliance incentives, to assist the tenant in securing prompt refrigerator replacement (at the time of failure) with an efficient unit. Targeted programs could also be designed to reach the low-income customers with water- and space-heating improvements. Most of these services should probably be delivered through local agencies and organizations, to reduce costs and improve communication and customer acceptance. The effectiveness and efficiency of the door-to-door program could possibly be increased by coordinating with the gas utilities to deliver services specific to gas (e.g., water-heater insulation and water use reductions, space heating efficiency, range replacement programs) in the same visit.

In the commercial class, the avoidance of lost opportunities argues strongly for concentrated efforts on new-construction, renovation, and rehabilitation. These efforts would affect primarily lighting and (in new and rehabbed space) HVAC, with smaller effects on refrigeration and other end uses. Additionally, programs should also be focused on programs which assist commercial tenants who pay electric bills due to their landlords' lack of incentive to invest in conservation manuals.

Also in the commercial class, it would be appropriate to accelerate a public-sector institutional program, such as a comprehensive retrofit program for electrically-heated schools. As noted above, this is a group of customers which is likely to have seriously under-invested in efficiency, to have severe market barriers to further investment, and whose inefficiency is likely to impose significant costs on the public. As staffing allows, other government and institutional customers could be included in this program, which would be part of the ramp-up to comprehensive retrofit throughout the commercial class.

5. VALUING EXTERNALITIES IN LEAST-COST PLANNING

Q: How should environmental and other external effects of power plant construction and operation be reflected in utility planning?

A: The effects should be reflected in three ways. First, for effects which will be mitigated, CECo should include reasonable estimates of the cost of mitigation. Second, for residual effects which will be internalized through taxes and fees, CECo should include those internalized costs. Third, for the residual effects which remain after mitigation efforts, and which will not be internalized, CECo should include estimates of the social cost of these effects in the societal cost tests. The third category contains true externalities; the first two categories are simply projections of internalized costs.

5.1 Internal Cost Effects of Acid Rain Legislation

Q: What is the likely effect of acid rain legislation on CECo's internalized costs?

A: The most dramatic and immediate effect is the requirement of significant SO_2 emission reductions at Kincaid by 1995, which will require a scrubber or the use of low-sulphur coal. Starting in 2000, all of CECo's coal and oil units will have to purchase SO_2 allowances, for emissions above a base level, which will generally be their emissions level in 1985.[15] If the units produce less than their allowed level, they can sell the extra allowances to other utilities or independent power producers. Low-NO_x burners (which are not very expensive) will be required on non-cyclone coal units. NO_x requirements for cyclone units will be established by EPA, but they are unlikely to be much more expensive than the low-NO_x burners.[16]

Q: What effect will passage of pending acid rain legislation have on the value of DSM for CECo?

A: First, if Kincaid switches to low-sulphur coal, CECo's fuel costs and hence its avoided costs will be higher than currently projected, starting in 1995.[17]

Second, the SO_2 emissions trading program will increase CECo's avoided costs. Starting in about 2000, every ton of SO_2 emitted by CECo plants will require CECo to buy one allowance (if it is over its baseline emission level), or sell one less allowance (if CECo is under the baseline emission level). More energy generated by the coal units implies more allowances used, for a given fuel type and set of emission

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[15]For Kincaid, the level would be 1.2 lb SO_2 times Kincaid's 1985 fuel use in MMBTU. The base period may be 1985-87 for some units; the base calculation may also change in the final stages of the legislative process.

[16]This analysis is based on S1630. It is my understanding that HR3030 would also have the same effects.

[17]The prices for low-sulphur coal are also likely to rise, although the magnitude of the increase will depend on the response of utilities to the legislation.

controls. Roughly speaking, CECo's low-sulphur coal units emit 0.85 - 1.1 lb of SO_2 per MMBTU, while Collins emits 0.73 and Kincaid will be able to emit no more than 2.5. At 10,000 BTU/KWh, 1 MWh would require 10 MMBTU; for a typical CECo unit, that would produce about 10 lb of SO_2. Therefore, whatever an allowance is worth, 200 MWH of generation would produce about 1 ton of SO_2 and require about one allowance.

The value of each allowance will depend on the details of the final legislation, on the demand (a function of new coal and oil-fired power plant construction, retirements and repowerings, and usage of existing units) and on the supply (a function of the cost of low-sulphur fuels and of emission control technologies). For the Administration bill, ICF (1989) estimated that allowances would trade for $651-711 in 2000, $527-650 in 2005, and $575-800 in 2010, all in 1988 dollars. The current legislation provides for the EPA to offer a small number of allowances each year at $1500 in 1990 dollars. Thus, the value of an allowance might be $500-1500, and each MWh of marginal fossil generation might cost $2.50 to $7.50 in emissions allowances, in 1990 dollars. These values, and improved estimates as they become available, should be incorporated in CECo's utility and societal cost tests.

5.2 Valuing Externalities

Q: How can the residual externalities be valued in comparing demand and supply options?

A: CECo can, and should, include the value of externalities, either by directly estimating the cost to society, or by inferring that cost from the costs of required controls. These techniques are discussed in Appendix Parts 3, 4, 5 and 6 to this testimony.[18]

Q: What values of externalities would you recommend using at this point?

A: I would suggest using the following values for major utility air emissions:

CO_2	\$0.011 per pound
SO_2	\$0.88 per pound
NO_x	\$2.00 per pound

The NO_x value is considerably lower than the values implied by ICF's analysis of the WEPCo decision, as discussed in Appendix Part 3. Estimates of the value of other air emissions, water consumption, oil spills, the economic externality of oil imports, and other external impacts should be added to these major pollutants. However, the three air emissions enumerated above are likely to comprise most of the value of the externalities associated with CECo's marginal generation.

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[18]The costs in some of the attachments are expressed in terms of \$/pound of sulphur and of carbon, and in others are expressed in terms of \$/pound of SO_2 and of CO_2. Care should be exercised in comparing the estimates in various sources.

Q: What might those three types of air emissions be worth for a typical CECo low-sulfur coal unit?

A: At emission rates of 1 lb SO_2, 0.7 lb NO_x, and 210 lb CO_2 per MMBTU, the total externality would be about $4.60 per MMBTU or (at 10,000 BTU/kWh) 4.6 cents per kWh. Further analysis is likely to support higher values, and the additional externalities will also add to the value. On the other hand, acid-rain controls are likely to reduce the emission rates, and much of the SO_2 cost will be internalized starting in 2000. If conserved energy is resold to other utilities, the avoided externalities should be based on the type of generation being avoided by the other utility. As CECo conservation starts to displace not only the energy from existing power plants, but also the construction of cleaner new power plants (projected in the late 1990s on other utility systems or about 2005 on CECo's own system), the avoided externalities will tend to decline.

6. CONCLUSIONS

Q: Please summarize your conclusions with regard to CECo's Least-Cost Plan.

A: CECo has not properly analyzed DSM potential or economics. CECo should be required to prepare a plan for identifying and capturing all conservation which passes the societal cost test, including the effects of off-system sales and externalities. In evaluating programs and measures, CECo should be required to compare the cost of an option to its lifetime benefits. CECo should orient its plan around market sectors and the elimination of market barriers.

CECo should capture all currently cost-effective DSM as soon as administratively feasible with particular focus on lost efficiency opportunities, should promptly implement large-scale DSM capability-building programs concentrating on disadvantaged and vulnerable customer groups, and should ramp up to full implementation of all cost-effective DMS programs in sufficient time to allow profitable long-term off-system sales and avoid capacity additions.

Q: Does this conclude your testimony?

A: Yes.

Table 3.1: Summary of Conservation Expenditures and Savings for Selected New England Utilities

Utility	Total program cost (1990$) [1]	Program life (yrs) [2]	Avg. Annual cost [3]	% of '87 revenues [4]	Avg. Incrmtl. MWh saved/yr [5]	% of '87 sales [6]	MWh saved in last yr of prog. [7]	% of '87 sales [8]	Total MW saved [9]	% of '87 pk load [10]
BECo	$213,800,000	5	$42,760,000	4.0%	105,360	0.9%	526,801	4.4%	116.9	4.4%
COM/Electric	$69,000,000	5	$13,800,000	3.9%	49,387	1.2%	246,936	5.8%	46.4	5.2%
CL&P	$624,915,000	10	$62,491,500	4.1%	174,117	0.9%	1,741,170	9.1%	466.25	11.8%
WMECo	$117,742,000	10	$11,774,200	4.3%	30,676	0.9%	306,755	8.5%	42.9	5.7%
CVPS	$124,361,000	10	$12,436,100	8.2%	32,318	1.9%	323,182	19.2%	64.7	14.8%
EUA	$60,000,000	5	$12,000,000	6.4%	36,634	1.7%	183,172	8.4%	53	7.0%
MECo	$37,000,000	1	$37,000,000	3.7%	121,130	0.8%	121,130	0.8%	53	2.2%
NEES	$1,484,595,000	20	$74,229,750	5.3%	114,250	0.9%	2,285,000	17.7%	1162.3	28.2%
UI	$35,000,000	3	$11,666,667	2.4%	24,112	0.5%	72,336	1.4%	30.6	2.7%

Notes:
[2]: The duration of the program described in the source document, though it is likely that most programs will be run for a longer period of time.
[3]: [1]/[2]
[4]: Utilities' 1987 annual ultimate consumer revenues from the Energy Information Administration's Financial Statistics of Selected Electric Utilities, 1987 (published in 1989), except for the NEES figures, which are from NEES's 1987 annual report.
[5]: [7]/[2]
[6]: Utilities' 1987 annual ultimate consumer sales from the Energy Information Administration's Financial Statistics of Selected Electric Utilities, 1987 (published in 1989), except for NEPCo's figures, which are from its 1986–95 Long Range Forecast.
[8]: See [6].
[9]: These figures represent MW saved in the last year of the program.
[10]: Utilities' 1987 peak load from Interim Report for NEPOOL Capability Responsibility for the May 1988–October 1988 Capability period, except for the CVPS figure (CVPS' 1989 Annual Report),the MECo figure (1986–95 Long Range Forecast) and the CL&P and WMECO figures (both from Northeast Utilities' 1989–98 Long Range Forecast).

NOTES TO TABLE 3.1

All the figures were obtained from utility testimony or reports, except for 1987 ultimate customer sales and revenues, which are from the EIA's Financial Statistics for Selected Electric Utilities 1987. The figures for capacity and energy savings represent A best attempt at culling data from the utility reports, which often lacked summaries of the savings their conservation plans would incur. Statistics for utilities' 1987 peak load, unless otherwise stated, are from the Interim Report for NEPOOL Capability Responsibility for the May-October 1988 capability period.

The Boston Edison (BECo) figures are taken from BECo's March 1990 Results of the Phase II Collaboration on Conservation Programs. BECo's summary figure for capacity savings do not include BECo's winter residential programs. These programs save an additional 15.7 MW, or .5% of 1987 peak load. BECo is a summer-peaking utility.

The COM/Electric figures are taken from COM/Electric's Results from the Massachusetts State Collaborative, Phase II.

CL&P reports load effects over 20 years. However, budget figures were only available for the first ten years of the program. Consequently, Table 3.1 represents only the program's first ten years. The MW savings given are for summer effects. The winter effects are slightly lower, at 450.46 MW in 1999, the program's 10th year. The savings after 20 years are 571.9 MW of summer reduction (455.1 in the wintertime) and 1,938 MWh of energy conserved. CL&P's budget figures are from Northeast Utilities' Private Power Producers and Conservation and Load Management status report (4/1/90). The savings figures are from the March 1, 1990 Forecast of Loads and Resources, filed with the Connecticut Siting Council.

Central Vermont Public Service's (CVPS) figures were taken from its Status Report filed in Docket no. 5270 (2/26/90). The CVPS program is still under negotiation in the collaborative, unlike the other programs in Table 3.1. The proposed CVPS program includes fuel-switching of electric space and water heating to fossil fuels. CVPS' 1987 peak load was obtained from its 1989 annual report.

Eastern Utilities' (EUA) conservation figures were drawn from the February 1990 Results from Phase II of the Collaborative Planning Process. At the time the report was written, proposed residential programs had not yet been reviewed or approved. Therefore, the expenditures and savings listed are for the C&I sector only. To reflect this in the table, columns [4], [6], and [8] express EUA's conservation expenditures and savings as a percentage of its C&I revenues and sales only.

The Massachusetts Electric Company (MECo) conservation figures were taken from testimony and exhibits submitted to the Massachusetts Department of Public Utilities, Docket 89-194/195, in September 1989.[1] MECo's 1987 peak load was obtained from volume three of MECo's Long Range Forecast 3 for 1986-95. MECo's program will continue for several years; the table provides only first-year projections.

The New England Electric System (NEES) data are taken from summary tables in New England Electric Conservation and Load Management Annual Report of May 1990. The MWh and MW savings exclude line loss benefits. The capacity saving shown in the table (1,162 MW) is the summer peak reduction.

United Illuminating (UI)'s capacity and energy savings figures come from its Energy Action '90 report. The figures are derived from summaries UI provided of each residential and commercial program's savings.

Western Massachusetts Electric Company's (WMECo) figures are taken from its September 1989 report, Conservation and Load Management Program Plan for the 1990's, and from the subsequent Conservation and Load Management Program Update of March 8 1990. The capacity savings figure was obtained by adding up the maximum annual capacity savings for each conservation program. WMECo is an affiliate of CL&P. Both are subsidiaries of Northeast Utilities (NU).

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[1] MECo is part of NEES, so these figures should be read as a subset of the NEES program.

Table 3.2: Summary of Projected 1990-91 Conservation Expenditures and Savings for Major California Utilities

Utility	Program Expenditures [1]	% of '87 revenues [2]	Incremental MWh saved/yr [3]	% of '87 sales [4]
PG&E				
1990	$106,770,000	2.2%	452,400	0.7%
1991	$118,410,000	2.4%	529,900	0.8%
SCE				
1990	$68,000,000	1.3%	922,800	1.5%
1991	$69,900,000	1.3%	922,800	1.5%
SDG&E				
1990	$13,056,000	1.0%	59,900	0.5%
1991	$21,642,000	1.7%	90,600	0.8%

Notes:
[1]: Source for utility figures: Report of the Statewide Collaborative Process, January 1990; dollar figures are nominal dollars.
[2]: Utilities' 1987 annual ultimate consumer revenues from the Energy Information Administration's Financial Statistics of Selected Electric Utilities, 1987 (published in 1989).
[4]: Utilities' 1987 annual ultimate consumer sales from the Energy Information Administration's Financial Statistics of Selected Electric Utilities, 1987 (published in 1989).

Table 3.3: Summary of Past Conservation Expenditures and Savings for Selected Utilities

Utility	Period covered [1]	Cummulative costs [2]	Cost of last yr of prog. [3]	% of '87 revenues [4]	Incremental MWh saved in last yr of prog. [5]	% of '87 peak load [6]	Incremental MW saved in last yr of prog. [7]	% of '87 sales [8]
Austin	1985–8	$38,950,000	$9,030,000	2.3%	21,100	0.4%	13	0.9%
CMP	1987–9	$35,460,000	$20,780,000	3.7%	83,600	0.9%	NA	NA
NEES	1987–9	$73,270,000	$37,020,000	2.7%	142,600	0.7%	54	1.4%
PG&E	1981–8	$530,570,000	$34,680,000	0.7%	388,700	0.6%	29	0.2%
Seattle	1981–7	$74,240,000	$9,990,000	4.1%	16,700	0.2%	NA	NA
SCE	1981–8	$441,410,000	$29,980,000	0.6%	375,400	0.6%	96	0.7%
WEPCo	1987–9	$114,010,000	$38,760,000	3.5%	126,700	0.6%	32	0.8%

Notes:
all figures are from Geller and Nadel (1989); all costs are in 1987 dollars.

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