TVA BONDED INDEBTEDNESS CEILING

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BEFORE THE

COMMITTEE ON THE BUDGET

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FEBRUARY 15, 1979

U.S. SENATE,
COMMITTEE ON THE BUDGET,
Knoxville, Tenn.

The committee met in the Supreme Court Building of the State of Tennessee, Hon. James R. Sasser presiding.

Senator SASSER. Hearings of the Senate Budget Committee will come to order.

OPENING STATEMENT OF SENATOR SASSER

Senator SASSER. I've been asked to make some announcements this morning by the State court, one of which is no smoking; so we would ask everyone to please refrain from smoking this morning. I want to express my appreciation publicly to Judge Parrot and to the State court of appeals for allowing us the use of their facilities this morning.

I might say that this hearing is held in connection with the deliberations of the Budget Committee of the U.S. Senate. We're making a concerted effort in the Congress and in the Senate Budget Committee this year to get a strong handle on a Federal budget, and on Federal spending.

REMOVAL OF TVA'S BONDED INDEBTEDNESS CEILING

In 1976, the Tennessee Valley Authority came before the Congress to get the bonded indebtedness ceiling lifted at that time. Now, there was considerable controversy in the Budget Committee of both the House and the Senate as to whether TVA's bonded indebtedness ceiling should be lifted in 1976. By holding these hearings today, we're getting the information necessary for the Senate Budget Committee and hopefully, for our colleagues on the House side.

So, we're here under the auspices of the Senate Budget Committee and under the auspices of our chairman, Senator Edmund Muskie, of Maine.

ELECTRIC ENERGY OPTIONS OF TVA

Last November 29, the General Accounting Office issued a report entitled, and I quote, "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority." Now, this document represented the first major review of TVA's power program by the General Accounting Office in over 19 years. It was a comprehensive document which detailed many options available to the TVA, and these

options address the future approach to accommodating electrical energy supply and demand in the Tennessee Valley area.

PROJECTION OF FUTURE POWER NEEDS OVERESTIMATED

The most important conclusions of this report indicate that future electricity demands in the Tennessee Valley could be lower than the TVA has predicted. The report states, and I quote, "Our projections indicate that there could be excess capacity ranging from 6,700 to 24,800 MW in the year 2000". The General Accounting Office examines TVA's load forecast and makes projections of future demand for the Tennessee Valley Authority power service area. GAO's high forecast is 17 percent lower than TVA's own forecast, and GAO's low projection of peak demand is 40 percent lower than TVA's own projection.

So, this raises some basic issues which must be addressed. The General Accounting Office has questioned TVA's projection of the future power needs of the Tennessee Valley area, and the General Accounting Office says that demand for electricity in the valley could be 17 to 40 percent lower than TVA is projecting for the year 2000. The General Accounting Office goes on to say that if their load demand projections are correct, TVA would, "need no new expansion beyond its seven nuclear powerplants through the end of the 20th century".

REEVALUATION OF TVA'S EXPANSION PLANS

So, I repeat, the General Accounting Office's projections have raised serious questions which must be answered and which must be addressed. If the GAO projections are correct, then TVA needs to reevaluate its position in this matter before making plans to expand its capacity beyond that which has already been planned.

Now, recently the Carter administration announced plans to submit legislation to the Congress, which would increase TVA's borrowing authority by $15 billion—increase it from $15 billion to $30 billion. The Carter administration has been persuaded that the TVA will need this additional borrowing authority in order to expand its power generating capacity to meet future demands beyond the year 2000.

IS INCREASED BORROWING AUTHORITY NECESSARY?

Now, let me say, and make it clear at the outset of these hearings, it's my belief and firmly held conviction that the Tennessee Valley Authority needs flexibility to grow and to meet future power needs. However, I've been concerned by GAO's report, and by the General Accounting Office's demand forecast. If the GAO's forecast is correct, this raises serious questions about the need to expand TVA's borrowing authority by 100 percent.

So, the purpose of this hearing is to examine the GAO report. I intend to be objective. This is a factfinding hearing. I want to question the representatives of the General Accounting Office very carefully about GAO's projections. I also want to question the TVA concerning its own projections which indicate that an expansion of generating capacity may be necessary. I also want to question a panel of experts from the Oak Ridge National Laboratory and the University of Ten-

nessee concerning their independent views of future electricity needs in the Tennessee Valley area.

FIRM FINANCIAL BASE NEEDED FOR FUTURE EXPANSION

So, let there be no question about it now, we must provide a firm financial base for TVA. We must assure that the TVA has the ability to grow and to meet the power demands of this area. We must assure that we never have an energy shortage in Tennessee, and we must assure that we have the energy to expand our economy and provide new job opportunities for all of our people.

So, the purpose of this hearing is to clear the air and to get the facts; and in order to support an expansion of TVA's bonding authority, I want to have all the facts when I appear before the Senate Budget Committee. We have two very responsible and very respected agencies of the Federal Government at loggerheads here, and we need to try to resolve this impasse.

FUTURE ELECTRICITY DEMANDS IN TVA AREA

Now, I think it's necessary to make one additional statement. The purpose of this hearing deals solely with the demand projections for the Tennessee Valley area. The question before this hearing is: "Can TVA meet its future electricity demands without increasing its generating capacity?" This hearing is not to discuss the kind of new generating capacity that may be needed. This hearing is not to determine whether TVA needs to build a new nuclear powerplant or some other kind of power-generating facility. That is simply not the issue. This hearing is simply to determine if a need for capacity expansion actually exists. If there is need for additional capacity, then we must deal at a later time with the question of the type of energy production that might be needed.

TVA IMPACT ON ECONOMY OF AREA

So, I open these hearings today under these guidelines. We're not here to discuss rates, and we're not here to discuss nuclear powerplants. We are here to discuss a more basic question, the future electricity demand in the Tennessee Valley area; and we're here to assemble additional facts regarding what the future holds for the TVA and what the future holds for the people of the Tennessee Valley area, and I have a responsibility as a Member of the U.S. Senate from Tennessee, and as a member of the Senate Budget and Appropriations Committees, to thoroughly understand the needs of the Tennessee Valley Authority. This agency affects the lives and the pocketbooks of every man, woman, and child in the Tennessee Valley area. It's important to all of us, and we must assure a bright future for TVA if we're to assure a bright future for our people. I want to make it clear that we can never shortchange ourselves on energy, or I think we will surely shortchange the future of the valley.

Having said that, we'll get into calling our witnesses. We'll call first the representatives of the General Accounting Office, led by Mr. J. Dexter Peach, who's the Director of Energy and Minerals Division, and his staff.

Mr. Peach, if you would be good enough for the purpose of the record to introduce your colleagues, we would appreciate it.

STATEMENT OF J. DEXTER PEACH, DIRECTOR, ENERGY AND MINERALS DIVISION, GENERAL ACCOUNTING OFFICE, ACCOMPANIED BY JOHN CLARK, ATLANTA REGIONAL OFFICE; MITCH WILLIAMSON AND JOHN BROWN, WASHINGTON OFFICE; AND COY BALEW, ATLANTA REGIONAL OFFICE

Mr. PEACH. Thank you, Senator. I have with me today, starting at my left, Mr. John Clark of our Atlanta regional office, Mr. Mitch Williamson of our Washington office, Mr. John Brown of our Washington office, and Mr. Coy Balew of our Atlanta regional office. All of these gentlemen were involved in some way in working on the report that we issued on TVA in November. I, myself, am Director of the Energy and Minerals Division of the General Accounting Office.

We appreciate your invitation today to discuss our recent report entitled "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority." I'll focus my statement today on two areas in which you expressed special interest.

The conclusion in our report that TVA could meet power needs through the year 2000 without constructing any more central station powerplants beyond those under construction or licensed, by emphasizing instead energy conservation, improved power management, and the use of renewable resources; and

The implication of our report on TVA's request to increase its borrowing authority above the existing $15 billion.

DIFFERENT PROGRAMS AND PRIORITIES NEEDED

TVA has important responsibilities not only as a supplier of electricity, but also as an energy leader. Our work showed a need for different programs and priorities if TVA is to reflect national energy goals and to continue its role, since its creation in 1933, as a national yardstick.

When we started our work, TVA's future planning was based on a July 1977 single load forecast which projected an average annual electricity growth rate of 4.5 percent for a 15-year period. We believe the use of a single estimate for electricity growth implies that the amount of growth required is predetermined when, in fact, considerable influence can be exercised. It is for this reason that we developed two alternative projections designed to evaluate the effects of various conservation and other programs consistent with emerging national energy goals. Our high projection indicated an average annual growth rate to the year 2000 of 4 percent and our low projection an average annual growth rate of 2.7 percent.

Of course, we cannot state with certainty that either of our projections will precisely represent the future. I believe they do show, however, that increased emphasis on conservation and demand management could reduce substantially the electricity which will be required if such measures are not taken.

TVA AS A LEADER IN ENERGY CONSERVATION

We believe TVA has the opportunity to demonstrate the benefits of pursuing various demand options in residential applications, power management, and solar alternatives. By exercising various options, TVA could: (1) Reduce the growth rate of electricity demand, (2) make the existing power system more efficient, and (3) defer new generating systems. For example, TVA could save electricity and reduce energy-related costs in area households by implementing the three residential programs in the national energy plan. These include appliance efficiency standards, thermal standards for new construction, and several measures to encourage insulating existing residences.

PRESENT CONSTRUCTION PROGRAM ADEQUATE FOR NEAR FUTURE

Many options also exist for meeting TVA's region power needs other than through traditional focus on large central station nuclear construction. Our analysis showed that completion of plants presently under construction or licensed could, when coupled with a new efficiency in consumption, meet demand through the early 1990's. With expanded conservation, improved power management, and the use of renewable resources, our analysis showed the region could meet its power needs through the year 2000 without thermal plant construction beyond that now in the licensing process. This would allow time for evaluation, development, and testing of alternative options before making additional commitments to large central station plants.

BETTER PLANNING AND FORECASTING SYSTEM NEEDED

To take advantage of this opportunity, we recommended that TVA abandon its practice of issuing a single forecast based largely on extrapolation of historic funds. Instead, TVA should develop a long-range comprehensive plan and several demand forecasts which could better reflect changing national goals. Such a plan could assess optional courses of action both from a cost-effectiveness viewpoint and in terms of TVA's yardstick function. TVA and the public could then evaluate the benefits and costs of alternative electricity futures and, as our projections suggest, consider initiatives which could influence future trends in electricity use.

While doing our work, we maintained an open dialog with TVA regarding our tentative findings and conclusions including a briefing of the now Chairman of the TVA Board, after his appointment as a Board member was announced. We believe TVA's overall response has been positive, particularly in its efforts to improve its planning and forecasting system. In July 1978, TVA developed several forecasts and extended its forecasts further into the future. In addition, TVA expanded its conservation-related programs.

TVA's most recent projections include four forecasts, the lowest of which is close to our high projection. We believe this approach is a step in the right direction and will offer TVA management some new opportunities for considering various options for the future.

ENERGY SUPPLY ALTERNATIVES

As part of TVA's long-range comprehensive plan, we recommended that it undertake the following demand option:

Increase efforts to implement national energy goals;

Actively encourage installation of heat pumps in all new construction, in conjunction with the education and certification of heat-pump installation and maintenance;

Study and implement seasonal and time of day rates;

Expand the use of interruptible contracts, but offer them on a regular interruption basis rather than on an emergency;

Initiate a program to switch off hot water heaters and larger air-conditioners during the peak hours; and

Evaluate and pursue opportunities for matching variable loads in the region.

UTILIZATION OF SOLAR ENERGY

To further decrease electricity demand, TVA should:

(1) Promote the use of solar passive building design with incentives such as design awards for builders, similar to the heat-pump and supersaver home programs.

(2) Design a strategy similar to the above promotion for solar water heating. In addition, TVA should provide alternatives for making these systems economically competitive for the consumer (such as reduced rates), since they are less costly to the power system than adding new generation capacity.

(3) Participate with the Department of Energy in the research and development of solar space heating and cooling for application in the region.

If the above options and other TVA initiatives do not adequately reduce power demand, TVA should consider applying a power rate surcharge, or issue bonds to provide money that could be used as an incentive to further conservation and the use of renewable resources.

APPLICATION/DEMONSTRATION MODELS

Concerning energy supply alternatives, TVA should undertake an application/demonstration of cogeneration technologies, flue gas desulfrization technologies in its coal-fired plants, and construct commercial-scale atmospheric fluidized bed combustion. Federal funding should be requested for that portion of those costs that exceed TVA's incremental cost per kilowatt. This would prevent TVA's customers from bearing the additional cost of a demonstration that benefits the Nation as a whole.

NATIONAL ENERGY PRIORITIES

If TVA carries out the recommended programs, it can regain its position as an energy leader and as a model for the utility industry. Not only the Tennessee Valley, but the entire Nation, stand to benefit. To assure this outcome, we believe the Congress should revise TVA's legislative charter to better reflect current national energy priorities. TVA should be charged with:

Leading in the development of electricity management plans and programs,

Encouraging energy conservation and the most efficient production and use of energy,

Encouraging the use of renewable resources, and

Assuring adequate public involvement in energy planning and policymaking.

I might digress just a moment from my prepared statement, Senator, to add some emphasis to say that we do think this is an important recommendation. The role of the Tennessee Valley Authority as a leader in the energy area and as a producer of electric energy has grown tremendously. Its role has evolved from that which was originally set out in the legislation creating TVA. We think with the energy situation today and with this growing role of TVA, it would be a reasonable time to update its charter to assure that it follows courses of action which we currently see it undertaking now.

TVA BORROWING AUTHORITY

In regard to TVA borrowing authority, the Congress authorized TVA to incur a total indebtedness of up to $15 billion to finance its power program. As of September 30, 1978, TVA had $7.2 billion indebtedness outstanding and projected an outstanding level of $9.1 billion by September 30, 1979.

Although our TVA study did not directly address the need for additional borrowing authority at this time, GAO has also conducted a recent review of cost overruns on three TVA nuclear plants under construction. That review indicates that borrowing of $11.8 billion will be needed to finance the construction of those three plants and all other nuclear plants now under construction which are scheduled for completion by 1986. An internal TVA study, which we did not verify, shows that the $15 billion borrowing authority could be exceeded by 1983 and indebtedness could reach $28 billion by 1988. In addition, some funding would be required to carry out the type of programs which we recommended in our report.

It seems clear that at a minimum TVA will need an increase in its borrowing authority to about $20 billion just to finish the nuclear plants already under construction. Beyond that, the additional amount needed and the time frame for when it will be required could vary significantly. As our alternative projections have indicated, the need for adding additional capacity is based on many assumptions and uncertainties, and there are various options available for decreasing or meeting demand that could have significant impacts on TVA's borrowing needs.

CONGRESSIONAL OVERSIGHT OF TVA OPERATIONS

This is the key reason we suggested in our report closer congressional oversight of TVA operations. We recommended that TVA's plans should be reviewed and commented on by as wide a spectrum of regional citizens and institutions as practicable and by the Department of Energy, to assure consistency with national priorities. TVA,

when its final plan is finished, should submit it to the Congress. The Congress should then evaluate and monitor the implementation of the plans. We, of course, would stand ready to assist Congress in this regard.

That concludes my prepared statement, Senator. I and members of my staff will be happy to answer any question you have.

IMPOSE SURCHARGE FOR ADDITIONAL CONSERVATION SAVINGS

Senator SASSER. Well, thank you, Mr. Peach. I found the GAO report to be very informative, and I think it had some excellent ideas in it. I don't know how many of them were entirely new and unique, but the report was very helpful.

There are some questions that do come to mind immediately. The General Accounting Office report has made several recommendations and listed various options for reducing TVA demand, and the report states, and I quote from it: "If the options do not reduce demand adequately, TVA could effect additional conservation savings by applying a surcharge or issuing bonds that would result in similar effects."

Now, could you elaborate on that proposal, Mr. Peach?

Mr. PEACH. Yes, Senator, there are a number of conservation programs we've suggested, and other programs TVA could undertake to reduce demand. The suggestion of a surcharge comes about after you follow these programs, and find at a point in time that they're not as successful as you would like. You could then follow the approach of applying a surcharge or issuing bonds in order to obtain the capital needed to provide incentives to induce additional conservation and undertake conservation-related kinds of programs.

Either way, whether you imply implementing a surcharge approach, or whether you issue additional bonds, eventually there are costs involved that get back into your rate system.

WOULD SURCHARGE BE COMPATIBLE WITH TVA ACT?

Senator SASSER. Well, the matter of a surcharge, I question the advisability of that. First, it appears to me that it would be inflationary, and possibly ineffective in reducing demand, and frankly, I'm not sure that the TVA Act would allow the imposition of a surcharge. The TVA Act requires rates to be as low as possible, and directs that the sale of power be made to the, and I quote, "ultimate consumer without discrimination as between consumers of the same class."

Now, did the GAO review the restraints of the TVA Act before making this particular suggestion with regard to a surcharge, to your knowledge, Mr. Peach?

Mr. PEACH. I'll ask Mr. Williamson of my staff to respond.

BENEFITS DERIVED FROM SURCHARGE

Mr. WILLIAMSON. Yes; we did look into it, and it would depend upon the approach used. We believe an increased price for the electricity would induce conservation and create the capital needed to be

used in other conservation programs, and in the long term these conservation efforts could possibly delay or totally postpone any future central construction, so that the cost to the ratepayers of the valley would be less.

Senator SASSER. Then, you think the surcharge would be compatible with the TVA Act, I presume?

Mr. PEACH. I think it would be. I think the issue you're raising though, Senator, certainly is a legitimate question that would have to be looked at carefully if TVA should choose to follow that course of action.

As you're probably aware, that is one of our recommendations with which TVA has said it is in disagreement and a course of action that it would not choose to follow. Recognizing that the surcharge option would be a controversial alternative is one of the reasons we included in our recommendation the option of using the bonding authority which they do have.

DIFFERENCES IN GAO LOAD FORECAST AND TVA RESPONSE

Senator SASSER. Agencies which are the subject of General Accounting Office reports have 60 days to file their further comments with the House Committee on Government Operations and the Senate Committee on Governmental Affairs. Now, the TVA in its response to the Government Operations Committee of the House said, and I quote:

> The General Accounting Office load forecast failed to take into account transmission losses, outdoor lighting, and interdivisional electricity sales within TVA. Thus, if these elements had been taken into account, GAO's lowest load forecast would have found that TVA needed 4,000 to 5,000 MW of added generating capacity in this century.

Now, that was the response that was filed with the Senate Committee on Governmental Affairs by the TVA to the GAO report. Now, my question is this, is it true that the General Accounting Office failed to include these elements in its forecast, and second, if these elements are included, is TVA's statement of added generating capacity correct?

Mr. PEACH. Let me answer that a couple of ways, Senator. Only late last week did I first see a copy of TVA's letter to the committees of the Senate and the House.[1] That was not an issue raised by TVA in their official comments on our report, so just since last week have we been looking into this particular question.

My understanding at this time is that the projections we developed are on a comparable basis with the forecast we used for TVA. In other words, the TVA projection of 4.5 percent also does not include those factors, nor does our low projection of 2.7 percent and our high projection of 4 percent. I also believe from our preliminary work that a question exists as to whether including those items would have any significant effect on the peak required, which is what you usually build your generating systems to meet. What I would like to do is to complete our looking into this area and provide something for the record that would attempt to reconcile this issue including the question of just how it effects peak demand, and the implications of adding those features into both sets of projections and what it would mean.

[1] See p. 113.

GAO AND TVA PROJECTIONS INCOMPLETE AND INADEQUATE

Senator SASSER. If you would do that and provide that for the record, I think it would be very helpful in making the record complete on this particular issue, and I think we do need to have that controversy resolved and laid to rest at some point if we can do so.

[The following was subsequently supplied for the record by GAO:]

GAO PROJECTIONS AND PEAK DEMAND FOR TVA SERVICE AREA

The GAO projections of peak electrical demand for the TVA service area do not ignore outdoor lighting, interdivisional TVA power use, losses, etc., as TVA alleges. As with other figures in the report, the TVA and GAO projections are based on different methodologies. Further, because both TVA's and GAO's projections of peak demand are derived from projections of total electrical usage, differences in the assumptions and methodologies used to derive the projections of total electrical energy usage cause differences in the peak demand projections.

As mentioned, both TVA and GAO used a methodology which derives system peak demand from the projection of electrical usage. TVA projected electrical usage using the methodologies and assumptions which are described in our report. GAO, using different methologies and different assumptions, derived GAO high and low projections for various years between 1975 and 2000. These projections, along with TVA's projections, are shown in Table II–4, page II–2, of our report. The figures in this table, TVA's and GAO's, exclude outdoor lighting, interdivisional TVA power use, losses, etc. Because of this, the figures can be compared.

As pointed out on the next page of the report, "In the 1977 TVA Load Forecast, peak demand was projected to grow at about the same rate as total demand." Thus, we projected a peak demand growth which was roughly the same as the growth of total electrical usage in our high and low projections. The results of this methodology are shown in Table II–6, page II–14 of our report. Again, TVA's projections are included for comparison. The 1975 base figure of 18,600 megawatts used in this table is a total TVA system figure, and thus includes outdoor lighting interdivisional TVA power use, losses, etc. Because our 1975 base figure from which we projected peak demand is for the entire TVA system, the projections shown in this table are for the entire TVA system, using the methodology described above.

TVA uses a different methodology which takes into account the various historical load factors (relationship of average demand to peak demand) of different classes of customers. These load factors are then applied to TVA's predictions of electrical usage and a peak demand for each class of customer is derived. The sum of the individual customer peaks is the system peak.

Senator SASSER. Now, the General Accounting Office report reads, and I quote, reading from the report now, "the data on which the TVA and General Accounting Office projections are based are incomplete and inadequate." Now, that seems to indicate that there is a considerable margin of error in not only your projections, but perhaps in TVA's projections. Now, what effect does this lack of data have on the projections, and what can be done to improve the data? Does GAO have any recommendations on that?

Mr. PEACH. In a moment I'll ask a member of my staff to respond in a little bit more detail to that question, Senator, but it might be a good time to say that obviously when you're dealing in this business of projections, and looking into the future, it's pretty hard to say with any certainty whether one set of projections is exactly right or wrong. My original suggestion and the one we emphasized most strongly to TVA is that you should have a variety of projections which are based on alternative assumptions, you need to maintain your development of information throughout the period of time, and try to measure what's

happening against your projections and adjust them accordingly as you get a better feel for reality.

This is a course of action which we now see TVA following in terms of moving to four forecasts, and we understand that they may be moving to, perhaps, an even greater number of alternative forecasts. But in terms of specific inadequacy of the data, I'll ask Mr. Clark if he'll comment.

UTILITIES SUFFER FROM INCOMPLETE DATA BASE

Mr. CLARK. Senator, there is a general lack of end-use consumption data throughout the utility industry such as appliance saturation, the average annual usages of appliances, and the makeup of the industries and commercial businesses. There's an incomplete data base and TVA is not the only utility suffering from that. It's national, but it is a problem. We recognized this with their projections, and ours reflects the same problems.

Senator SASSER. Have we got any recommendations of how we can improve this data base?

Mr. CLARK. Yes, sir, we have recommended and TVA is doing work in the area of surveying for appliance usage and they're metering appliances. They're surveying for ownership of types of appliances, and we feel like a lot more can be done in this area.

FEDERAL FUNDING FOR TVA EXPERIMENTATION

Senator SASSER. Well, certainly I think more needs to be done so that we can have the clearest and most accurate data possible to make future projections. I think it's crucial that accurate projections can be made of energy demands for the future.

Now, the General Accounting Office has made several recommendaations that TVA take the lead in demonstrating various supply alternatives, such as fluidized bed gas systems. Now, I commend the General Accounting Office for this recommendation. Now, the President has made it clear that he wishes the Tennessee Valley Authority to be an energy leader, and I applaud that policy. The GAO recommended that in these instances where the Tennessee Valley Authority demonstrates or takes the lead in energy alternatives, experimental energy alternatives, that any added cost over and above the traditional power costs should be federally funded.

Now, let me say at the outset that I agree with this statement. When TVA ventures into speculative areas, and the Nation as a whole stands to benefit, and derive benefits from their experimentation then I don't believe that the ratepayers of TVA should pick up the tab solely for developing alternative energy sources, or for this experimentation.

Would the GAO care to comment on this beyond what you have in your report?

Mr. PEACH. Not other than to say, Senator, that I agree with you. What we tried to do in this particular case was look at two things: (1) TVA has this yardstick function that was originally set out for them, and (2) they also are the biggest utility, so what better opportunity to demonstrate some of these new technologies in terms of an actual demonstration showing how they can work. They also have a very capable staff and capable people.

Certainly when you're talking about demonstrating these kinds of technologies which could serve a national purpose, are somewhat speculative as to how successful they are going to be, and how they would fit into the overall system, then it should not be the ratepayers of TVA who bear all the risks and cost. But, it should be paid from regular appropriated funds from the Federal Government.

IS SOLAR ENERGY AN EFFECTIVE ALTERNATIVE?

Senator SASSER. Well, I agree with the General Accounting Office recommendation a hundred percent on that, and I suspect the ratepayers in the Tennessee Valley area will also agree a hundred percent.

One of GAO's energy demand alternatives is the use of solar energy through such applications as solar passive building design, solar water heating, and solar space heating. Now, the report states that solar could further reduce the demand for power by more than one-half billion killowatts annually by the year 2000. Now, I'm advised that the Tennessee Valley area cannot economically utilize solar at this time. Your report goes on to say though, and I quote, "in the TVA region solar space heating and cooling is not currently cost effective in any situation." Now, since solar cannot economically be utilized, why does the General Accounting Office list it as an effective alternative here in the Tennessee Valley area for reducing area demand for electricity, if we can't effectively use solar here?

Tell us why you don't think we can effectively use solar here, if that's the case, Mr. Peach.

Mr. PEACH. I'll ask Mr. Williamson to answer that question.

COST EFFECTIVE SOLAR OPTIONS

Mr. WILLIAMSON. What we have analyzed in this particular situation was several solar options. The first which you mentioned was solar passive building design. That's such things as the kind of materials and colors you use and the location of shade trees, things of that nature that will happen once the building is built, and continue to happen which save energy. That option is definitely cost effective. The second option we reviewed was solar hot water heating. In our particular analysis solar hot water heating is also cost effective in the Tennessee region. The only option which we reviewed that was not cost effective at this point in time is the solar space heating and cooling, which I don't believe is cost effective any place in the United States at this time. But the two options that are cost effective were considered in our analysis and savings were projected in terms of both energy and dollars if these options were applied in the region.

Senator SASSER. I see. You say that the solar space heating or cooling is not cost effective, you don't think, anywhere in the United States, not just the Tennessee Valley area?

INITIAL CAPITAL OUTLAY DETERRENT TO SOLAR HEATING AND COOLING

Mr. PEACH. I'm not sure that that's the way I want to come out on it as to whether it's not cost effective anywhere in the United States. There are a number of issues concerning this area and we have other work ongoing in the General Accounting Office looking at solar heating

and cooling demonstration programs which the Federal Government is pushing and other things that are happening in the solar area. Obviously the big thing you have to get over, particularly in the solar heating area, and there are many more problems when you go to cooling as opposed to just solar heating, is the initial cost of the equipment, and the willingness of people to make that initial capital outlay for something that maybe will pay back over a long period of time. I think that's still one of the basic hangups or problems even in the Southwestern areas and Florida where they have much more sun and where you can anticipate that it's more likely to be cost effective now.

INCREASED USE OF ELECTRICITY IN TENNESSEE VALLEY AREA

Senator SASSER. The General Accounting Office report states, and quoting from the report, this is a quote, "per household electricity use grows from about 16,000 kilowatts in 1976, to almost 20,000 kilowatts per year in 2000." Now, because of so many all-electric homes in the Tennessee Valley area, the average TVA residential customer uses roughly twice as much electricity as does the average American home. Now that the residents of the valley are beginning to practice better conservation, I would expect to find the average amount of electricity consumed to be reduced or at least not increase appreciably; yet you've indicated an average increase in consumption of 6,000 kilowatts between now and the year 2000 here in the Tennessee Valley area. What's the reason for that? What's your rationale?

Mr. PEACH. Mr. Clark.

MORE EFFICIENT APPLIANCES COSTLIER TO OPERATE

Mr. CLARK. Senator, there's several reasons that the average usage would increase. For instance, the freezers and refrigerators that are frost-free, which are coming on the market now and replacing the older models, use roughly 50 percent more energy than the older models. There are projections for increased use of electrical vehicles, far beyond what we presently have. These sort of things could cause usage to go up even though the efficiency might be much greater than at present.

COST OVERRUNS IN TVA CONSTRUCTION

Senator SASSER. At the begining of the hearings, I stated that these hearings were not desiged to discuss the pros and cons of nuclear power plant construction in the TVA area. In the past at hearings of the Public Works Appropriations Subcommittee in the Senate, of which I'm a member, I've expressed my concern about the massive cost overruns in TVA in the construction of TVA's nuclear reactors. In your testimony you stated that the General Accounting Office has been studying the TVA construction program.

Now, when do you anticipate that report to be completed and be released to the Congress and to the public?

Mr. PEACH. I anticipate it will be released within the next month, Senator. It's in the final stages of processing within our Office. We have already received TVA's comments on the draft of the report, and

are in the process of incorporating those and getting it ready for signature.

ADDITIONAL BORROWING TO COMPLETE PROJECTS

Senator SASSER. Well, you've testified that your review indicates that additional borrowing of $11.8 billion will be needed just to complete those seven nuclear plants that are already under construction, well, I think six that are under construction now, or have been ordered by the TVA. Now, tell us why you project such continued cost escalations? I noticed in the morning newspaper that TVA is indicating they can be completed, I think, for $2 billion.

Mr. PEACH. Well, I think the question is where your starting point is from, Senator. We use as our starting point, when we talk of a cost escalation, the initial estimate that was made at the time the authorization was put forth for the plan originally. I haven't looked at what's been spent so far and how much more they think it will take to complete construction, but when we talk in terms of that amount of cost escalation we're talking in terms of the original estimate that was made to where it stands right now in terms of what it would take to complete it.

CONTROL COST ESCALATIONS IN NUCLEAR PLANT CONSTRUCTION

Senator SASSER. I see. Well, what do you think can be done by the Tennessee Valley Authority to get these cost escalations in the construction of nuclear plants under control?

Mr. PEACH. Well, I guess the first statement I would make is that the Tennessee Valley Authority doesn't necessarily find itself in a unique position in experiencing significant cost overruns on nuclear powerplants. A situation that we are aware of, for example, in the Pacific Northwest indicates that five plants originally expected to be constructed for about $4 billion are now going to cost them over $10 billion.

It seems to be a continuing problem as we learn more about what is going to be required to license and construct a plant, of stretching out the amount of time that is required for the construction, of imposing new and additional regulatory requirements as we learn more about problems that we see in the nuclear energy area, and all of these things seem to have that one common feature of adding to the cost ultimately that is required for the plant.

Senator SASSER. Well, Mr. Peach, I want to express my appreciation to you and your colleagues from the General Accounting Office for appearing here today and giving us your views on the TVA and its future vis-a-vis the Tennessee Valley area.

I have a number of additional questions which we'll submit for the record and would ask you and your colleagues to respond to these questions as rapidly as you could after you get them.[1]

Mr. PEACH. We'd certainly be pleased to, Senator. We'd be happy to hear any question you may have.

Senator SASSER. Thank you.

Our next witnesses will be a panel headed by Mr. John Moore, who will moderate the panel discussion. Mr. Moore is a professor of eco-

[1] See p. 103.

nomics at the University of Tennessee. Mr. Moore, if you would just ask your panel members to come forward as you're doing there and then introduce them for the record after they're seated.

PANEL OF WITNESSES ON REGIONAL ECONOMIC GROWTH AND ELECTRICITY DEMAND [1]

STATEMENT OF JOHN MOORE, PROFESSOR OF ECONOMICS, UNIVERSITY OF TENNESSEE

Mr. MOORE. Thank you, Senator Sasser. I will introduce the panel members. On my far left is William Chandler from the university. We seem to have chosen up sides here a bit, but moving from left to right we have Bill Goolsby from the university, Robert Bohm from the university, Roger Carlsmith from Oak Ridge National Laboratory, Eric Hirst from Oak Ridge National Laboratory, and Jack Gibbons from the University of Tennessee. On behalf of the entire panel, I would like to express our thanks to you for giving us the opportunity to share with you our views on the important question of regional growth and electricity demand. I think we all agree that this is a crucial issue both from the standpoint of the region and the Nation.

What I suggest that we do is to proceed with formal statements from four of our panelists, all of whom have agreed to limit their comments to not more than 10 minutes, and then have questions and discussion at that point.

Our first panelist is Dr. Eric Hirst who is on leave from Oak Ridge National Laboratory at the present time with the Minnesota Energy Authority.

Senator SASSER. Dr. Hirst.

STATEMENT OF ERIC HIRST, ENERGY DIVISION, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENN.

RESIDENTIAL ENERGY AND ELECTRICITY PROJECTION IN THE TVA REGION

Dr. HIRST. I participated with the GAO in the preparation of their report during the summer of 1977. The work that I did with GAO dealt with residential energy and electricity projection in the TVA region.

Part of our work involved looking at what TVA did in terms of their projections and the projection methodologies, and then developing some alternative projections using models that we had developed at Oak Ridge.

TVA FORECASTS NOT STATE OF THE ART

As of the summer of 1977, the projections methodologies that were being used by TVA to produce these forecasts were definitely not state of the art. It was my judgment at the time that the approaches

[1] See biographical sketches of panel members, p. 119.

that TVA was using then could have been significantly improved, and I think a major conclusion that I drew was that as the Nation's largest electricity-generating organization, and as a major Federal energy agency, TVA really ought to be in the forefront with respect to methodologies for projecting future electricity demand and also energy demand, since the two are closely coupled.

DATA BASE SUPPORTING METHODOLOGIES INADEQUATE

A second conclusion that I drew from our examination of TVA's activities was made earlier by GAO, and has to do with data. In the residential sectors, the data base supporting the methodologies that TVA used, and therefore the methodologies we used, were completely inadequate. A collection of detailed data is required. It's expensive, but I think it's very important to do. The kind of issues that need to be addressed in this data collection activity include estimates of equipment ownership per household by type of fuel and by housing types. How many single-family homes use electricity for heating? Do they use heat pumps or resistance heating? How many have gas water heaters as opposed to electric water heaters? How does that differ by type of housing units, single family versus multifamily, and versus mobile homes? How do these equipment ownership patterns affect patterns of fuel use; electricity, gas, oil, and alternative fuel? How much energy is consumed for particular kinds of appliances, and how does this vary over a time? Do new refrigerators consume more electricity than refrigerators that were installed 5 years ago? What's the thermal performance of the housing stock, both new housing units and existing housing units?

All of this information is important for developing good projections, and it's also important for operating good conservation programs. You need this kind of information to determine where your potentials are, where you can develop programs for cost-effective conservation.

WIDER RANGE OF FORECASTS NEEDED TO DEVELOP PROJECTIONS

In the July 1977 load forecast report that TVA issued, they prepared only a single forecast—one curve that showed their best estimate of electricity consumption into the future. This lent an air of certainty to the forecast that is unjustified for any complicated forecasting exercise. As others have said before me, and I'm sure will say after, developing energy-use models and making projections with them is a very inexact process. There are lots of uncertainties in the inputs to such models, and also in the models themselves. One way to deal with this uncertainty is to develop a range of forecasts so that people in authority who have to make decisions about conservation programs and new generating facilities, can weigh the likelihood of the different outcomes and look at the different forecasts.

RESIDENTIAL ELECTRICITY CONSUMPTION FORECASTS

The forecast that TVA produced in July 1977 for residential electricity consumption in 1990 was 64 billion kilowatt-hours. The fore-

casts that we produced with our model at the Oak Ridge National Laboratory were considerably lower. They ranged from 52 to 56 billion kilowatt-hours, 12 to 19 percent lower than TVA's estimates.

Now, so far I've been kind of critical of TVA and as I said earlier, this is based on my perceptions of what they were doing as of the summer of 1977. As I look at what they've done since then, the picture is entirely different.

EXPANDED TVA ENERGY CONSERVATION PROGRAM

For example, the July 1978 load forecast prepared by TVA remedy many of the problems that I saw a year earlier. The 1978 report from TVA includes four sets of projections instead of just one. I think this is a significant and important step forward in that it allows the TVA Board and the public in general to see what the range of alternatives are for the TVA area. I was also pleased to note that the range of forecasts that TVA produced for residential electricity demand in 1990 was almost exactly the same as the range of forecasts that we had produced at Oak Ridge the year before. That's not to say that their forecasts and ours are right; but it's sort of comforting that we covered pretty much the same kind of range.

A comparison of the approaches that TVA used in 1977 and 1978 is very encouraging. Many of the suggestions that are made in the November 1978 GAO report had already been adopted by TVA by the time the report came out.

I guess my final comment would be that TVA should be strongly encouraged to continue these activities. They have in the last 2 or 3 years greatly expanded the scope and vigor of their energy conservation program, and this activity certainly ought to continue. I think they also should be encouraged to continue their development of better models of electricity demand and energy demand. They're doing this; they just need to be encouraged to continue this activity.

FEDERAL FUNDING FOR DETAILED DATA ON ENERGY USE

I think the TVA Board also ought to appropriate money so that TVA can collect detailed data on energy use in the valley, for all sectors, not just the residential sector, but also the commercial and industrial sectors. Although the cost of collecting data is high, it's insignificant compared to the cost of new powerplants, and so I think it is a very cost cost-effective investment, both for developing better conservation programs, and also for building better forecasts.

Thank you.

PREPARED STATEMENT OF ERIC HIRST, ENERGY DIVISION, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENN.

PROJECTIONS OF FUTURE DEMAND FOR ELECTRICITY IN THE TVA REGION: THE RESIDENTIAL SECTOR[1]

The material presented here is based on work done at ORNL for the U.S. General Accounting Office during the summer of 1977. Results of this work appear

[1] This is a summary of oral testimony presented before Senator Jim Sasser at hearings on future power projections in the Tennessee Valley, held on Feb. 15, 1979, in Knoxville, Tenn. Research sponsored by the U.S. Department of Energy under contract W-7405-eng-26 with the Union Carbide Corp.

in chapter 5 and appendix II of the GAO report, "Electric Energy Options Hold Great Promise For The Tennessee Valley Authority," published in November 1978. Because the work on which this statement is based was done in mid-1977, my suggestions may be seriously dated.

My conclusions concerning TVA's projections of future residential electricity demand are:

ENERGY AND ELECTRICITY PROJECTION MODELS

1. The projection methodologies being used by TVA's Analysis Branch in 1977 were definitely not state-of-the-art. TVA used three different methods of preparing projections; results of these three were compared with each other and a final single projection was prepared, based on the judgments of the analysts. Unfortunately, none of the TVA methods was explicitly sensitive to both the engineering and the economic determinants of residential electricity and energy use. The method that TVA relied on most heavily is an econometric model that relates residential electricity demand only to economic determinants, such as fuel prices and incomes. Thus, the effects of government conservation programs (developed by TVA, state energy offices, and the U.S. Department of Energy) and new residential energy technologies (e.g., solar water heaters, improved electric heat pumps) could not be explicitly included in the TVA model. Therefore the effects of such conservation programs and improved technologies were either analyzed in an offline ad hoc fashion or ignored. As the Nation's largest electric utility and a major Federal energy agency, the TVA should be active in the development and application of improved energy and electricity projection models.

DATA BASE OF ELECTRICITY MODELS INADEQUATE

2. The data base supporting the 1977 residential electricity models was incomplete and inadequate. Although collection of detailed data on residential energy use patterns (e.g., equipment ownership by fuel type and by housing type, residential uses of different fuels, energy requirements for different types of equipment, thermal performance of existing and new homes) is quite expensive, the cost of these activities is insignificant compared with the costs of new electricity generating facilities. The value of improved forecasting models constructed with a more detailed, accurate, richer data base is likely to be immense in that it will allow TVA to better anticipate the need for and timing of new powerplants.

TVA'S ACTIVITIES PLAY ACTIVE ROLE IN SHAPING FUTURE DEMAND

3. In their July 1977 load forecast, TVA prepared only a single forecast for the TVA Board. This lent an air of certainty to the forecast that is unjustified for any such complicated forecasting exercise. It also obscured the fact that TVA has various tools that can be used to influence growth of electricity demand in the TVA region. TVA's activities are not limited to only meeting projected demand; they can (and are) playing an active role in shaping future demand.

RESIDENTIAL ELECTRICITY CONSUMPTION PROJECTIONS

4. The forecast that TVA produced in the July 1977 forecast showed residential electricity consumption at 64 billion kilowatt hours in 1990. Projections developed with the ORNL residential energy use model (calibrating the ORNL model to accurately predict residential electricity use in the TVA region from 1970 through 1976) showed a range in 1990 residential electricity use of 52–56 billion kilowatthours (12–19 percent lower than TVA's estimate). Our high estimate assumed that no government conservation programs were adopted. Our low estimate assumed vigorous and effective implementation of TVA's $uper $aver Home program, attic insulation program, and heat pump certification program; plus adoption of the residential conservation programs proposed by President Carter in the April 1977 National Energy Plan.

LOAD FORECASTS

5. The July 1978 Load Forecasts prepared by TVA remedy many of the problems seen in 1977. The 1978 report includes four sets of projections rather than only one: (1) Medium economic growth, expanded conservation. (2) Medium economic growth, new end-use technologies. (3) High economic growth, expanded conservation, and (4) High economic growth, new end-use technologies.

These forecasts show a range in future electricity use that should help the TVA Board make decisions about TVA programs to encourage energy conservation and/or to construct new power plants. The range in estimates of 1990 residential electricity demand was 51 to 58 billion kilowatthours, almost identical with the range of results from the ORNL projections.

IMPROVED FORECASTING METHODOLOGIES

6. A comparison of the approaches used and results presented in the 1977 and 1978 load forecasts produced by TVA are very encouraging. TVA appears to have adopted many of the suggestions made in the GAO report (before the GAO report was even published). The TVA should be encouraged to continue their progress in developing improved forecasting methodologies, collecting better and more detailed data to support these improved models, publishing a range of forecasts, and—most important—developing and implementing a set of vigorous conservation programs that will encourage TVA residents to adopt cost-effective energy conservation measures.

Senator SASSER. Well, thank you, Dr. Hirst, and I understand that you flew in from Minnesota today to give us the benefit of your thoughts, and I appreciate that very much.

Dr. HIRST. Well, it's about 40° warmer here.

BETTER DATA BASE OF ENERGY USE ESSENTIAL

Senator SASSER. Well, that's a good reason to come down here.

Dr. Hirst, a couple of times in your statement you touched on the fact that the data base, and the data figures were inadequate, and I think stated something that's very obvious, that having accurate data, even though it's expensive to collect compared to the construction of a powerplant, is very cost efficient.

What can we do about getting better data? I asked the General Accounting Office witness that and felt that we need to sort of amplify, perhaps, on his views.

RANDOM SAMPLING OF HOUSEHOLDS

Dr. HIRST. Well, I would recommend a number of approaches. One would be to survey households, have people go to a random sample of households in the TVA area and interview people. Ask them questions about the appliances and equipment that they own, the type of fuels they use, and so on. This is something that TVA could do in a less expensive manner than one would think, because the Energy Information Administration in DOE is now conducting a very detailed, comprehensive survey on residential energy consumption throughout the Nation, and it's likely that TVA could use the exact same interview form, and basically piggyback on what DOE is doing.

MONITOR ELECTRICITY AND NATURAL GAS CONSUMPTION

I think, in addition, TVA should monitor electricity and also natural gas consumption in a sample of the valley's homes; not just total consumption, but submetering, where you determine the electricity used for particular appliances. I think the important ones there are space heating equipment, water heating, and refrigerators. These are the largest energy uses in the residential sector, and I think TVA should make the effort to collect actual data on what consumption is for these different pieces of equipment.

Senator SASSER. Now, you made the remark earlier that you found TVA's—initially, you found TVA's demand forecasts techniques to be inadequate or lacking, and now that you find their demand forecast techniques to be improved, at least in your view, Dr. Hirst. Could you elaborate on how they are improving their demand forecast techniques?

METHODOLOGIES USED IN TVA EXPANDED CONSERVATION PROGRAM

Dr. HIRST. Only partly. I'm not really familiar with the details of TVA's methodologies today. My impression is that the original forecasting methodology that they used in 1977 was a purely econometric approach, in which they estimated future electricity consumption as a function only of economic variables; fuel prices and income. This kind of approach does not allow you to consider changes in technology, solar water heating, wood burning, and improved heat pumps. Things like that cannot be explicitedly incorporated into the models.

Also, the kind of conservation programs that TVA now has underway—the super saver home program, the heat pump program—these kinds of programs cannot be entered into the model. So, use the model to build a projection of consumption based only on prices and income, and then after you develop this projection, make some judgments about how these different programs and new technologies affect demand.

What I think TVA is doing now is trying to develop models that are more disaggregate so that they deal not just with overall residential electricity use, but with the specific end-uses. They're also trying to incorporate some of the engineering factors, the technological factors, that influence electricity demand.

Senator SASSER. Thank you very much, Dr. Hirst. Mr. Moore, who is your next witness here?

Mr. MOORE. Dr. Robert Bohm of the department of finance at the university.

Senator SASSER. Dr. Bohm.

STATEMENT OF DR. ROBERT A. BOHM, DEPARTMENT OF FINANCE, AND ASSOCIATE DIRECTOR, ENVIRONMENT CENTER, UNIVERSITY OF TENNESSEE

Dr. BOHM. Thank you, Senator. I have prepared a written statement for the record from which I will now read very selectively.

During 1977–78, along with several of my colleagues at the University of Tennessee, I worked on the General Accounting Office's evaluation of the Tennessee Valley Authority power programs.

In my remarks today, I would like to address several issues raised by the GAO study. First, I will review several alternative projections of energy demand now available for the TVA region. Second, I will comment briefly on the relationship of these demand projections to the possible necessity of raising TVA's borrowing authority from $15 to $30 billion. Finally, I will comment on my understanding of the rationale behind the GAO study of TVA power programs and the current relevance of the findings of that study. Let me emphasize at

the start that the statements I will be making are my own opinions and do not represent the position of GAO or the University of Tennessee.

PROJECTIONS OF ENERGY DEMAND AND SUPPLY

First, let's address the alternative projections of energy demand and supply. Two of the principal objectives of the GAO study as we've already been told today were (1) to evaluate the feasibility of TVA undertaking several national demonstrations of emerging energy technologies and conservation options, and (2) to establish grounds for financing these demonstrations out of power revenues or alternatively by means of appropriated funds. Until the summer of 1978, TVA provided only a single load forecast. The GAO demand projections were prepared to provide a context within which to consider alternative supply strategies and demonstration proposals.

Three projections of demand through the year 2000 were presented in the GAO report. The existing TVA forecast was taken as a representative high projection. Two lower GAO projections were prepared.

The GAO "high" projection was based on relatively rapid economic growth, no increase in the real price of electricity, and ineffective conservation programs. The GAO "low" projection assumed lower economic growth, an increasing real price of electricity, and increased efficiency in the use of power. Table 1 in my written statement contains data on the growth rates of electric energy demand in the TVA region presented in the GAO study, and compares these with the new 1979 TVA load forecast. These data illustrate two important points. First, all the projections, from both GAO and TVA, show a slowing down of demand growth over time, especially in the decade 1990 to 2000. The second point has to do with the vast array of alternative load forecasts now produced by TVA. A careful reading of the table will reveal that several of the 1979 TVA forecasts are, in fact, lower than the GAO low projection.

SUPPLYING PROJECTED ENERGY DEMANDS AT MINIMUM COSTS

Turning to the supply side, we adopted a baseline objective of meeting projected demands at minimum costs. It was from our supply side analysts that the conclusion was reached that if the GAO low demand projection proved correct, then TVA might not need additional generating capacity before the year 2000 beyond those plants under construction or planned. That essentially means, beyond the Yellow Creek plant. This conclusion must be kept in its proper perspective as an "if then" statement. What it really implies is that there is danger inherit in incorrectly forecasting demand either too high, which would result in waste, or too low, which would result in shortages.

With demand projections and minimum cost supply scenarios in hand, it was then possible to evaluate proposed energy demonstration programs and consider alternative methods of financing them. However, in the interest of time, I will skip over the methodology used, which has already been discussed at some length by Mr. Peach.

Senator SASSER. Let me say, Dr. Bohm, that I intend to read your report in toto, in detail; please continue.

Dr. BOHM. OK.

Senator SASSER. I'm not trying to rush you; I just want to assure you that we are very interested in what you're saying. I'm going to read every word of it.

RELATIONSHIP OF FUTURE POWER DEMAND AND TVA BORROWING AUTHORITY

Dr. BOHM. Turning to the relationship of future power demand and TVA borrowing authority, let me say this. Without careful analysis of the TVA's financial projections, it is impossible to state exactly how much borrowing authority is really needed. However, several important issues can be addressed which are raised by TVA's wish to increase its authority to $30 billion.

First, I think it's useful to dispense with the notion that unused borrowing authority will somehow "burn a hole" in TVA's corporate pocket and lead to construction of unneeded powerplants. TVA borrows money to finance capital outlays on new capacity required to meet projected demand. This chain of causation cannot be reversed.

The TVA's actual need to issue debt must be tied to projections of future demand of electricity and expected future cost of capital equipment.

Under conditions of low demand growth, TVA has two options: (1) Complete already planned facilities on schedule and undertake little or no new construction in the 1990's; or (2) extend the construction schedule of already planned facilities into the 1990's. Since TVA is required to have bonding authority to cover its financial obligations, the second option could lead to higher debt requirements as obligations from earlier years are extended and layered on top of those commencing in later years. Under either option, however, the key factor that might lead to a request for a higher borrowing authority is inflation. The TVA must make its financial plans in terms of nominal dollars rather than real or deflated dollars. As a result, some assumption as to the future rate of inflation must be made. The higher the rate of inflation assumed by TVA, the more likely is a request for additional borrowing authority at an early date.

FACTORS AFFECTING TVA'S BORROWING AUTHORITY

Now, what about the case where demand is above the low levels indicated by the GAO low projection? Then TVA must plan for additional new online capacity for the early 1990's, and financial obligations would begin in the 1980's. It should also be mentioned that the various national demonstration programs TVA is proposing to undertake, to the extent that they are funded out of power revenues, will draw heavily on TVA's borrowing authority. As far as borrowing authority is concerned, therefore, we can conclude that if TVA is now at or near its current debt ceiling of $15 billion, there is good reason to believe that additional borrowing authority will be needed in the early 1980's. Two factors that could lower this pressure on TVA's debt ceiling are lower power demands and a low rate of inflation. A third possibility might be built around heavier reliance on supply systems that have a relatively short construction period such as industrial cogeneration. With conventional coal or nuclear powerplants, a decision to build must be made 10 to 12 years before any power will actually come online. As a hedge against the risk of having too little productive or financial capacity, planners are likely

to overstate the energy demand growth rate and the assumed inflation rate. If the construction lag could be cut to 5 years, projections would have a somewhat higher degree of certainty about them, and upward biases resulting from a long planning horizon might be reduced thereby cutting the need for borrowing authority.

RELEVANCE OF GAO STUDY

Let us turn briefly now to the overall relevance of the GAO study. It has always been my opinion that the rationale behind the GAO study was presenting a case to establish TVA as a principal national demonstration agency in the energy field.

The current validity of the findings and conclusions of that report must be viewed within the time frame in which the study was conducted. The report was essentially finished in April 1979. The TVA had a complete draft in hand before the end of spring of 1978, and earlier access to much of the analysis.

Also, it should be noted that during 1977–78, those of us working on the study were trying to take aim on at least two moving targets. The first was the energy market. The second moving target we faced was the TVA itself. During the course of the GAO study, the membership of the Board of Directors changed, and TVA energy policy shifted from a unidimensional emphasis on large nuclear plants to open consideration of numerous energy supply-and-demand options. Many of the programs TVA initiated during 1978 were recommended in the GAO report. It is probably of little value to argue which of TVA's new programs are due to GAO efforts and which were due to TVA's new leadership. Rather, what appears to me to be significant is the fact that the vision of TVA as a national energy demonstration agency found in the GAO report can be seen to some extent in practice today in the operations of TVA.

Now, I'd like to draw just three brief conclusions. First, since the GAO report contains no load forecasts—no load forecasts other than those prepared by TVA—it is incorrect to imply that the GAO report says TVA has overestimated future electric energy demand. As I've indicated, alternative projections of future demand appear in the GAO report for the purpose of providing a context within which to evaluate energy supply-and-demand demonstration options.

CREATE PANEL TO ASSIST IN EVALUATION PROCESS

One of the recommendations of the GAO study was that TVA prepare several alternative load forecasts. The 1979 TVA load forecast contains seven alternatives, up from four last summer. In addition to the TVA forecasts, there appear also to be several non-TVA forecasts and projections in print. With so many available, it would seem that our attention should now turn to evaluating the validity of the assumptions underlying the various forecasts and projections, and the sensitivity of power demand to changes in the values of key variables. Ultimately, probabilities and weights must be attached to different values of the key parameters. I would go so far as to recommend that TVA create a panel of experts on regional growth, energy prices, and other important factors to assist in this evaluative process. Such a panel, consisting of both TVA and non-TVA personnel, could be made an integral part of the load forecasting process of the future.

TVA REQUEST FOR INCREASED BORROWING AUTHORITY JUSTIFIED

Second, it would appear that uncertainty regarding future demand growth, inflation, and the lag involved in bringing new capacity online leads to a conservative approach in forecasting loads and financial requirements. In other words, in its planning process, TVA will minimize risk by leaning toward the higher growth load forecasts and assuming relatively high inflation rates. Such risk-minimizing behavior may well be optimal under today's energy market conditions. It also implies, however, that TVA's request for increased borrowing authority may well be justified. Personally, I see no danger in increasing this authority to $30 billion.

ARE GAO RECOMMENDATIONS OUT OF DATE?

Finally, the question arises, is the GAO report "out of date"? I don't think so. Of course, the two GAO projections can be called out of date in the sense that the energy market has moved on since 1977. But how out of date can these projections be when the current TVA load forecast presents energy demand growth rates both above and below the GAO projections? Certainly it cannot be argued that the GAO recommendations on energy supply-and-demand demonstration programs are out of date. Prior to the official publication date of the GAO report, TVA initiated work in many of the areas recommended by GAO. Implying that the GAO report is out of date therefore represents an indictment of many of TVA's newest and most exciting programs.

Thank you.

Senator SASSER. Thank you, Dr. Bohm.

PREPARED STATEMENT OF DR. ROBERT A. BOHM, DEPARTMENT OF FINANCE, AND ASSOCIATE DIRECTOR, ENVIRONMENT CENTER, UNIVERSITY OF TENNESSEE

FUTURE ELECTRIC ENERGY DEMAND IN THE TENNESSEE VALLEY AUTHORITY POWER SERVICE AREA

My name is Robert A. Bohm and I am currently Professor of Finance and Associate Director of the Environment Center at the University of Tennessee (UT). During the past eight years, I have been engaged in research on the topic of energy supply and demand as well as on the related topic of the environmental impact of energy production. During 1977–78, along with several of my colleagues at the University of Tennessee, I worked on the United States General Accounting Office's (GAO) evaluation of Tennessee Valley Authority (TVA) power program.

The GAO report entitled "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority" was issued on November 29, 1978. The involvement of the University of Tennessee faculty and staff was greatest in chapters four through seven of the report. These chapters contain the analysis of future energy demand in the TVA region and consideration of alternative supply strategies for meeting projected demand. Also included in these chapters are evaluations of several proposed energy demonstration programs that would affect both the demand and supply side of the energy equation.

In my remarks today, I would like to address several issues raised by the GAO study. First, I will review several alternative projections of energy demand now available for the TVA region and discuss their meeting for future energy supply and the financing of TVA demonstration programs. Second, I will comment briefly on the relationship of these demand projections to the possible necessity of raising TVA's borrowing authority from $15 billion to $30 billion. Finally, I will comment on my understanding of the rationale behind the GAO study of TVA power programs and the current relevance of the findings of the study. Let me emphasize that the statements that I will be making are my own opinions and do not represent the position of GAO or the University of Tennessee.

PROJECTIONS OF ENERGY DEMAND AND SUPPLY

Two of the principal objectives of the GAO study were (1) to evaluate the feasibility of TVA undertaking several national demonstration projects for emerging energy technologies and (2) to establish grounds for financing these demonstrations out of power revenues or alternatively by means of appropriated funds. Until the summer of 1978, TVA provided only a single load forecast. The GAO demand projections were prepared to provide a context within which to consider alternative supply strategies and demonstration proposals. In this way, we were able to interject into our analysis the high degree of uncertainty that existed over the future course of electric energy demand. Proposed demonstrations of emerging technologies or conservation programs could then be more properly evaluated against scenarios of high and low energy demand.

Three projections of demand through the year 2000 were presented in the GAO report. The existing TVA forecast was taken as a representative high projection. Two lower "GAO" projections were prepared. Let me briefly review how these projections were made:

(1) For federal demand, the projections provided by the Department of Energy to TVA were taken as given.

(2) For residential demand, the Oak Ridge National Laboratory (ORNL) Residential Energy Model was adapted to the TVA region.

(3) For commercial and industrial demand, an aggregate economic model was developed and estimated especially for the GAO study.

The two models were capable of projecting future energy demand based on assumed rates of change in energy prices and regional economic growth. In addition, the ORNL model contained so-called engineering variables that allowed direct estimation of National Energy Plan impacts on TVA residential power demand.

The GAO "high" demand projection was based on relatively rapid economic growth, no increase in the real price of electricity and ineffective conservation programs. The GAO "low" projection assumed lower economic growth, an increasing real price of electricity, and increased efficiency in the use of power. Table 1 contains data on the implicit compound growth rates of electric energy demand in the TVA region presented in the GAO study and compares these with the TVA January 1979 Load Forecast. These data illustrate two important points. First, all projections show a slowing down of demand growth over time. Thus, to compare any projection in the GAO report through the year 2000 with the current TVA load forecast is somewhat misleading because the TVA forecast concentrates on the period to 1990 and thereby excludes the slow growth 1990–2000 decade. The second point has to do with the vast array of alternative load forecasts now produced by TVA (one of the major recommendations of the GAO report was that TVA prepare multiple forecasts). A careful reading of table 1 will reveal several of the 1979 TVA forecasts are lower than the GAO low projection.

TABLE 1.—IMPLICIT COMPOUND GROWTH FOR ELECTRIC ENERGY DEMAND IN THE TVA REGION

[In percent]

	Without Federal purchases	With Federal purchases
A. GAO study projections:		
1. From 1975 to 2000:		
TVA (1977)	4.8	4.5
GAO High	4.3	4.0
GAO Low	2.7	2.7
2. From 1975 to 1992:		
TVA (1977)	4.5	4.7
GAO High	4.0	4.3
GAO Low	2.7	3.4
3. From 1992 to 2000:		
TVA (1977)	3.4	2.9
GAO High	3.2	2.7
GAO Low	1.3	1.0
B. TVA January 1979 Load Forcast:		
1. From 1979 to 1990:		
High	4.5	5.1
Midrange	1.8–3.6	2.8–4.3
Low	1.0	2.2
2. From 1990 to 2000:		
High	4.8	4.1
Midrange	1.8–4.2	1.4–3.5
Low	.8	.6

Source: "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority." Report to the Congress by the Comptroller General, Nov. 29, 1978, p. 4 and 5; and January 1979 Load Forcast, Tennessee Valley Authority.

Turning to the supply side, we adopted as a baseline objective the meeting of projected demands at minimum cost. Utilizing linear programming techniques, it was then quite simple to construct minimum cost supply scenarios for each demand projection. Largely because of the favorable TVA load configuration, our supply side analysis was largely confined to finding the least cost methods of meeting baseload requirements. It was concluded that nuclear systems would be the least expensive through the mid-1990's with coal-based fluidized bed systems cheaper thereafter.

It was from our supply side analysis that the conclusion was reached that if the low demand projection proved correct, then TVA might not need additional generating capacity before the year 2000 beyond those plants under construction or planned (i.e., beyond the Yellow Creek Plant). Perhaps this conclusion can best be put in proper perspective with a quote from the UT Environment Center's report to GAO entitled, "The reader should be kept aware constantly that none of the [demand] projections presented have any claim to superiority or likelihood. Each is based on a different set of plausible assumptions about what the future will bring. The authors have attempted to keep their analysis free of their own personal feelings and biases, for the implications of being wrong are enormous in either direction. If the TVA projections are accepted as the basis for planning capacity additions, and one of the lower projections proves closer to the mark, valuable and scarce resources could be wasted. On the other hand, if one of the lower projections is accepted and proves too low, crash efforts or critical shortages could result."

With demand projections and minimum cost supply scenarios in hand, it was then possible to evaluate proposed energy demonstration programs and consider alternate methods of financing them. Proposed demonstrations that raised the cost to TVA rate payers above the minimum cost scenarios and also exceeded the direct benefits to residents of the region were clearly candidates for financing via the appropriations route. Demonstrations that yielded benefits to residents of the region or did not raise power costs might legitimately be funded out of power revenues. Clearly, a demonstration of an advanced energy supply technology must be evaluated differently under conditions of low and high projected energy demand. For example, with high demand a demonstration will yield needed power and merely replace some alternative production systems. Under such conditions a direct benefit accrues to the rate payers and hence it would seem appropriate to employ power revenue financing for part of the cost of the demonstration. In the case of low demand, additional generating capability would not be needed and hence from the point of the TVA system, the demonstration would create excess capacity. Obviously, in this latter case, heavier reliance on appropriated funds would be the desirable financing alternative.

FUTURE DEMAND AND TVA BORROWING AUTHORITY

Without careful analysis of the TVA's financial projections, it is impossible for me to state exactly how much borrowing authority I believe is needed in the future. However, even without being able to pinpoint an appropriate debt ceiling, several important issues raised by the request to increase the limit to $30 billion can be addressed.

First, let us dispense with the notion that unused borrowing authority will somehow burn a hole in TVA's corporate pocket and lead to construction of unneeded powerplants. TVA borrows money to finance capital outlays on new capacity required to meet projected demand. This chain of causation cannot be reversed. Investors that purchase TVA power bonds expect to receive both interest and eventual repayment of principal. These cash flows to investors are derived from TVA power revenues. Idle capacity does not produce revenue and as a result TVA's ability to meet its interest and principal repayment obligations would be called into question. Only if TVA could raise rates at will and with complete disregard for the cost of production, would it perhaps be possible to market bonds to finance unneeded capacity. I doubt that the electricity consumers of the TVA region or the Congress would permit such irresponsible fiscal behavior to continue for very long. To summarize, therefore, even if TVA wished to construct unneeded powerplants, great difficulty would be encountered financing them even in the presence of unused borrowing authority.

The TVA's actual need to issue debt must be tied to projections of the future demand for electricity and the expected future cost of capital equipment. Projections such as the GAO low demand projection imply little need for additional capacity beyond that already licensed or under construction. The first question

that must be answered, therefore, is with low demand growth would TVA need additional borrowing authority?

Under conditions of low demand growth, TVA has two options: (1) complete already planned facilities on schedule and undertake little or no new construction in the 1990's; or (2) extend the construction schedule of already planned facilities into the 1990's. Since TVA is required to have bonding authority to cover its financial obligations, the second option could lead to higher debt requirements as obligations from earlier years are extended and layered on top of those commencing in later years. Under either option, however, the key factor that might lead to a need for higher borrowing authority is inflation. The TVA must make its financial plans in terms of nominal dollars rather than real or deflated dollars. As a result, some assumption as to the future rate of inflation must be made. The higher the rate of inflation assumed by TVA, the more likely is a request for additional borrowing authority at an early date.

What about the case where demand is above the low levels indicated by projections such as the GAO low projection? The TVA would have to plan for additional new on-line capacity in the early 1990's and financial obligations would begin in the 1980's. It should also be mentioned that the various national demonstration programs TVA is proposing to undertake, to the extent they are funded out of power revenues, will draw upon TVA's borrowing authority to meet capital expenditures.

In conclusion, we can state that if TVA is at or near its current debt ceiling of $15 billion, there are good reasons for believing that additional borrowing authority will be needed in the early 1980's. Two factors that would lower the pressure on TVA's debt ceiling are lower power demands and a low rate of inflation. A third possibility might revolve around heavier reliance on supply system that have a relatively short construction period (as with industrial cogeneration)[1]. With conventional coal or nuclear baseload plants, decisions to build must be made 10–12 years before any power will actually come on line. As a hedge against the risk of having too little productive or financial capacity, planners are likely to overstate the energy demand growth rate and the assumed inflation rate. If the construction lag could be cut to five years, projections would have a somewhat higher degree of certainty about them, and upward biases resulting from a long 10–12 year planning horizon might be reduced thereby cutting the projected need for borrowing authority.

RELEVANCE OF THE GAO STUDY

It has always been my opinion that the rational behind the GAO study was to present a case for establishing a role for TVA as the principal national demonstration agency in the energy field. It was felt at the onset of the study that this traditional TVA function had atrophied over the years almost to the point where it was difficult to distinguish TVA from a private power company.

The current validity of the findings and conclusions of the GAO report must be viewed within the time frame in which the study was conducted. The majority of the work performed at UT was completed prior to the end of 1977. The report itself was essentially finished by April 1978. The TVA had a complete draft in hand before the end of spring, 1978 and access to much of the analysis at earlier dates.

Also, it should be noted that during 1977–78, those of us working on the study were trying to take aim on at least two moving targets. The first was the energy market itself. Demand parameters and elasticities were changing rapidly and new information on price trends, costs of emerging technologies, etc. appeared almost daily. It was clear that with so much flux in the market, no 25 year demand forcast could stand the test of time. As a result, we eschewed competing with TVA in the area of load forcasting and confined ourselves to preparing a set of projections within which energy supply and demand demonstration programs could be evaluated.

The second moving target we faced was the TVA itself. During the course of the GAO study, the complexion of the Board of Directors changed drastically, a new chairman was appointed and a new general manager named. The TVA energy policy shifted from a uni-dimensional emphasis on large nuclear plants to open consideration of numerous energy supply and demand options. Many of the programs that TVA initiated during 1978 are recommended in the GAO re-

[1] This point was suggested to me by William U. Chandler of the UT Environment Center.

port. It is probably of little value to argue about which of TVA's new directions are due to GAO's efforts and which to TVA's new leadership. Rather what appears to be truly remarkable is the fact that much of the "vision" of TVA as a national energy demonstration agency found in the GAO report can be seen in practice in the operations of TVA today.

CONCLUSIONS

Several conclusions can be drawn from the preceding discussion. First, since the GAO report contains no load forcasts other than those prepared by TVA, it is incorrect to imply that the GAO report says TVA has over-estimated future electric energy demand. Alternative projections on future demand appear in the GAO report for the purpose of providing a context within which to evaluate energy supply and demand demonstration options, and because TVA provided but a single forecast at that time.

One of the recommendations of the GAO study was that TVA prepare several alternative load forecasts. The January 1979 TVA load forecast contains seven alternatives. In addition to the TVA forcasts, there appear also to be several non-TVA forecasts and projections in print. With so many available, it would seem that our attention should now turn to evaluating the validity of the assumptions underlying the various forecasts and projections and the sensitivity of power demand to changes in the values of key variables. Ultimately, probabilities and weights must be attached to different values of the key parameters. I would go so far as to recommend that TVA create a panel of experts on regional growth, energy prices and other important factors to assist in this evaluative process. Such a panel, consisting of both TVA and non-TVA personnel, could be made an integral part of the load forecasting process in the future.

Second, it would appear that uncertainty regarding future demand growth, inflation, and the lag involved in bringing new capacity on line leads to a conservative approach in forecasting loads and financial requirements. In other words, in its planning process TVA will minimize risk by leaning towards the higher growth load forecasts and assuming relatively high inflation rates. Such risk minimizing behavior may well be optimal under today's energy market conditions. It also implies, however, that TVA's request for increased borrowing authority may well be justified. Personally, I see no danger in increasing this authority to $30 billion.

Finally, the question arises, is the GAO report "out of date"? I don't think so. Of course, the two GAO projections can be called out of date in the sense that the energy market has moved on since 1977. But how out of date can these projections be when the current TVA load forecast presents energy demand growth rates both above and below the GAO projections? Certainly it cannot be argued that the GAO recommendations on energy supply and demand demonstration programs are out of date. Prior to the official publication date of the GAO report, TVA initiated work in many of the areas recommended by GAO. Implying that the GAO report is out of date therefore represents an indictment of many of TVA's newest and most exciting programs.

TVA AS A NATIONAL ENERGY DEMONSTRATION MODEL

Senator SASSER. There are two or three points that you touched on that I'd like to pursue just very briefly. One, you made what I thought was a very interesting observation that the General Accounting Office report had as one of its aims to bolster a project to make TVA the national energy demonstration model, if I understood you correctly. Could you elaborate on that?

Dr. BOHM. Well, that might have been my interpretation of the aim of the study.

Senator SASSER. Did it come out the way it was intended to come out, do you think?

Dr. BOHM. Generally, I think it came out that way. My interest in the study was to essentially see if this was a good idea, I guess, and evaluate to what extent it would be feasible for TVA to play such a role.

COST OVERRUNS

Senator SASSER. You mentioned in your prepared statement the cost overruns at some of the nuclear plants. You indicated that you might have some ideas on how these cost overruns could be held to a minimum. Would you elaborate on that for us? I think we'd find that very interesting.

Dr. BOHM. I don't think that was in my statement, Senator.

Senator SASSER. Somebody called that to my attention that it was in your statement. Do you have any ideas along that line?

ENVIRONMENTAL STIPULATIONS EFFECT ON COST OVERRUNS

Dr. BOHM. My opinion on cost overruns is it has to do, really, with the rate of inflation you assume in your original cost projections, and there you're sort of guessing. If the rate of inflation turns out to be higher than you've projected then you'll have a cost overrun which is not a cost overrun in real terms, it's an imaginary one. The other place where cost overruns could cause serious problems would be if, in fact, the licensing regulations changed during the course of construction or planning, and the agency, for example, was required to meet new environmental stipulations. This would increase the cost of constructing the project over what was originally projected. In that case though, you can't have your cake and eat it too. If you want environmental protection you have to be prepared to pay for it.

GAO AND TVA DISAGREE ON INDUSTRIAL AND COMMERCIAL DEMAND FORECAST

Senator SASSER. All right. In assisting in the preparation of the GAO report there was some conflict between GAO and TVA with regard to industrial and commercial demand forecasts. Now, overall GAO's high growth forecast indicates less demand for electricity, than does the TVA forecast; yet in the industrial and commercial sector the high growth forecast of GAO is higher than TVA's, and I think you predict a demand of 177.8 billion kilowatt-hours in the year 2000, while TVA projected 169 billion.

Now, why would you predict the use of more electricity in the commercial and industrial sector than TVA would, and at the same time project a lower overall need for additional electricity.

Dr. BOHM. Perhaps I should start by pointing out that in the residential projection of the GAO report we had at our disposal the very sophisticated model that Dr. Hirst has just described. In the industrial and residential area we had no such sophisticated model. What we had to do was prepare some method of projecting demand in that sector. We put together a fairly simple economic model to do this; model in no way as sophisticated for example as the one that TVA was developing at the time.

I felt comfortable in doing this because I knew I wasn't preparing a load forecast, but merely a projection within which we could evaluate overall proposals for national demonstrations and so forth. The only reason our numbers are higher than their numbers is that's the way they caue out. There was no sophisticated reason one way or the other.

Senator SASSER. Well, thank you, Dr. Bohm. Who do you wish to call on next, Mr. Moore?

Mr. MOORE. Well, Senator, it's clear both Dr. Hirst's efforts and Dr. Bohm's efforts went into the GAO report. We thought that it might be helpful for you to have some estimates that were done independently of both the GAO and TVA.

Senator SASSER. Yes, it would be helpful.

Mr. MOORE. So, we have two panelists who will address themselves to that. Fortunately, there is an effort going on at the University of Tennessee, a continuing effort, that has to do with estimating energy needs for Tennessee, and Dr. Goolsby will speak to that, and then we will turn to some broader estimates for the valley area as a whole, to which Mr. Carlsmith will speak.

Senator SASSER. Dr. Goolsby.

STATEMENT OF WILLIAM C. GOOLSBY, ASSOCIATE PROFESSOR OF FINANCE AND DIRECTOR, TENNESSEE ECONOMETRIC MODEL, UNIVERSITY OF TENNESSEE

Dr. GOOLSBY. This testimony was prepared by myself and Dean Moore. Since Dr. Moore is an expert in the energy area, I asked him to assist me.

My primary responsibility is forecasting the State's economy, primarily through the Tennessee econometric model. Our primary responsibility in the center for business and economic research is to prepare reports for the State government, and for private agencies within the State to give them some idea of the future shape of the State's economy for budgeting and planning.

We've prepared several reports in that regard, including four economic reports to the Governor of the State, and two reports on energy resources and requirements within the State, and special purpose reports such as a report to the State government on the expected impact of the coal strike last spring.

I will skip over most of my testimony here and give you the gist of it.

Senator SASSER. I might say, Dr. Goolsby, that your testimony will be incorporated in its entirety in the record.

Dr. GOOLSBY. Thank you.

Senator SASSER. We'd appreciate a summary.

TENNESSEE AND NATIONAL ECONOMIES

Dr. GOOLSBY. The forecast that I made, of course, is not representative of the entire TVA area, since we only forecast for the State of Tennessee. At the present time we're anticipating a period of relatively slow growth for the United States and the State economies through 1985. We're expecting the rate of growth of the national economy to slow down during the last half of this year in response to the current restrictive monetary policies of the Federal Reserve Board and the efforts of the executive and legislative branches to reduce the Federal deficit.

We're expecting slow growth of around 1.5 to 2.25 percent for the State's economy, that is Tennessee's economy, in 1979, 1980, and 1981. After that we're expecting moderate growth rates of 3 to 3.5 percent

through 1985, as the National Government continues to exercise restraint in an attempt to maintain the stability of the dollar and to control the forces of inflation.

This slower growth is expected to result in a slower rate of job formation than we have experienced during the last decade, and we're anticipating this rate of growth in jobs will impact on our population growth rate, and slow it down during the period from now until 1985.

We have developed a sector of the State's econometric model that represents energy demand that includes a number of mathematical equations that attempt to predict the level of energy useage within the State, including that of electricity.

ELECTRICITY CONSUMPTION AND PRICE PROJECTIONS

Table 2 in our testimony shows the projection for electricity sector consumption, and price data through 1980 and 1985. We made this forecast for 1975 to 1985 to make it comparable with the GAO report, although we have not made any direct comparisons. This projection is based on our December 15, 1978, forecast by the Tennessee econometric model.

We're forecasting a compound rate of growth, as shown in table 3 of the testimony, of 3.1 percent per annum, in electricity consumption from 1975 through 1985. In terms of subsectors the estimates are: for residential consumption, 2.2-percent growth; commercial consumption, 3-percent growth; and industrial consumption, 4.2-percent growth. Also we're estimating about a 10-percent compound rate of increase in electricity prices over the 10-year period with rather negligible variations in price increases among the subsectors.

ANNUAL RATE OF GROWTH

Also from table 3, we are anticipating a decline in the rate of growth of electricity consumption between 1980 and 1985 relative to the earlier 5-year period. This lower growth rate is primarily a result of an expected slower average growth rate in the State's economy in the later period. The year 1975 was a recession year and our output was, at that time, considerably lower than the prerecession level achieved in 1973.

Consequently, we've had a rebound effect in the last few years. Since 1975, we have experienced 3 years of rapid growth in gross State product of 7.8 percent in 1976, 5.5 percent in 1977, and 3.5 percent in 1978. Combining these relatively rapid rates with the slower rates expected in 1979 and 1980, we still expect to average better than 4 percent per annum over the 5-year period. From 1980 to 1985, however, we expect to average about 3-percent growth per annum. Consequently, we would not expect the rate of growth in electric consumption to be as great in the later period.

ELASTICITY OF DEMAND FOR ELECTRICITY

Finally, table 4 shows the elasticity of demand for electricity with respect to price and increases in real output or personal income. In general, we expect a 1-percent increase in State output to increase electric consumption by 1.6 percent. However, this increase in con-

sumption will be tempered by price increases, since a 1-percent increase in price will result in a decline in electricity consumption of about one-half of 1 percent. Thus, the interaction of these two factors, price increases, and increases in real output determine the rate of growth of electricity consumption.

In summary, we would like to emphasize the following points:

NATIONAL AND STATE OUTLOOK TO 1985

First of all, we expect the national rate of growth to slow down, and we expect the State rate of growth to follow that slowdown. We anticipate that real growth will average 3.6 percent per year over the 1975 to 1985 decade for State output, and we find this consistent with a growth in electricity consumption of 3.1 percent when price increases are taken into account. Indeed, as far as total energy consumption is concerned, there has been some "uncoupling" of growth in real output and energy inputs in Tennessee since 1970 due to price increases, and we expect this to continue in the future. Net energy consumption per dollar of real gross State product fell by 8 percent between 1970 and 1975, and we estimate a further 16-percent decline in this figure for the decade ending in 1985.

IMPACT OF COAL ON ENERGY PRICES

Second, we are anticipating that energy prices will continue to rise at a pace considerably in excess of increases in the general price level. Our figures suggest a 10-percent average rate of increase in electrity prices, while the deflator for gross State product is expected to increase at a rate of about 6 percent during the 1975 to 1985 decade. Coal prices play an important role in our forecasts of electricity prices. In light of the United Mine Workers and BCOA labor agreement signed a year ago which calls for further rounds of substantial wage increases, and the fact that higher costs of surface mining associated with full compliance with the Surface Mine Act of 1977 have probably not been fully factored into the price of coal, there is intuitive support for the notion that electricity may continue to become more expensive relative to a representative bundle of other goods and services. Of course, as we move toward 1985, more of the electricity produced in Tennessee will come from nonfossil sources, and other factors may be of greater importance in explaining the price of electricity toward the end of the period.

INTERPRET PROJECTIONS WITH A DEGREE OF CAUTION

Third, as a final matter, we must urge that these projections be interpreted with some caution. The methodology of econometric model building for Tennessee has great strength to the extent that developments in this region are linked to the national economy, and to the extent that a requirement for internal consistency is imposed. There are limitations, however, and Mr. Hirst brought out one of those in his testimony here in that changes in technology that may occur in the future are, of course, not factored into this. The first thing that we use to forecast the future is our knowledge of the past, and past relationships are first modeled in the econometric model. Then after that we

have to impose on the model forecasts any special knowledge that we may have about technological changes. Also, exogenous factors such as a prolonged interruption of oil imports from Iran, or a rapidly expanding national economy, which we do not expect, could upset our projections. Also it should be remembered that these forecasts are based on historical structural relationships, some of which may have changed in recent years. We do, however, believe the underlying methodology is sound and that the forecasts can, properly qualified, be of value in a wide range of applications. Furthermore, the forecast is for the State of Tennessee alone, and it may not be completely representative of the entire TVA region.

Thank you.

Senator SASSER. Thank you, Dr. Goolsby.

[Dr. Goolsby's statement follows:]

PREPARED STATEMENT OF WILLIAM C. GOOLSBY, ASSOCIATE PROFESSOR OF FINANCE, AND DIRECTOR, TENNESSEE ECONOMETRIC MODEL, UNIVERSITY OF TENNESSEE; AND JOHN R. MOORE, ASSOCIATE PROFESSOR OF ECONOMICS, UNIVERSITY OF TENNESSEE

The Tennessee Econometric Model is an annual forecasting and simulation model for the state of Tennessee based upon the historical trends in the Tennessee economy relative to the national economy. It is a system of 192 mathematical equations that are solved simultaneously to provide a comprehensive and consistent forecast of state economic activity.

This forecast for the state's economy relies on a prior forecast of the natoinal economy prepared by Wharton Econometric Forecasting Associates, Inc. As you are undoubtedly aware, Wharton forecasts have a reputation for accuracy and reliability that is unequaled. Consequently, we do not attempt to duplicate their expertise at the national level. Instead, we concentrate on the state economy and attempt to forecast the deviations about the national trend that occur at the state level.

TENNESSEE ECONOMETRIC MODEL

The Tennessee Econometric Model has been utilized for many important studies of the state's economy during the past five years. We have produced four economic reports to the governor of the state on the state's economy and prospects for growth. These reports are widely used in state government for planning and budgeting.

The model has been used to project state expenditures and receipts to determine the need for tax increases. Two studies of state energy requirements and resources have been completed. Other special purpose studies have been accomplished, such as the report to state government on the expected impact of the coal strike in the spring of 1978. In addition, the forecasts have provided a basis for other studies by both public and private agencies.

TENNESSEE AND NATIONAL ECONOMIES

Tennessee's economy is quite different from the national economy in many respects. Perhaps the most significant difference is our heavy reliance on manufacturing. While Tennessee's economy is not as strongly dominated by manufacturing as some states such as Michigan or Ohio, manufacturing does constitute a larger percentage of total output in Tennessee than in the average state. In 1978, manufacturing comprised 35.9 percent of Tennessee's output and 24.7 percent of the national output.

Furthermore, Tennessee's growth rate has been considerably above that of the nation during the past decade, 3.8 percent real growth versus a national rate of 2.8 percent real growth in ouptut and a 4.2 percent real growth in total personal income versus a national rate of 3.4 percent. This more rapid growth can be attributed to the quality and discipline of the labor force, lower average wages, lower taxes, lower energy costs, and the favorable location of the state between the industrialized areas of the Northeast and Midwest and the rapidly growing southern states.

On the other hand, there are factors that contribute to a lower per capita income in Tennessee that are expected to persist. In 1976, Tennessee's per capita income was 83 percent of the national per capita income. The factors contributing to the lower per capita income are identified in Table 1.

Tennessee has a higher percentage of people with less than high school education, a higher percentage of black people, a higher percentage of female-headed households, a higher percentage of elderly people, a higher percentage of people living outside metropolitan areas, a lower percentage of people employed in durable goods manufacturing, and a lower percentage of people over 14 who are employed than the average for the United States. All of these factors would tend to predict a lower per capita income.

Tennessee does have a higher percentage of the population over 14 employed in manufacturing, but this employement is concentrated in the lower-paid nondurable manufacturing area and therefore tends to produce a lower per capita income.

These factors lead us to conclude that it is unlikely that Tennessee will achieve a per capita income equal to the national average unless there is a dramatic change in these demographic and economic characteristics. Since it is unlikely that such a change will occur, we anticipate that the rate of growth in Tennessee output and income per capita will tend to converge with that of the nation so that future increases in total state output and income above national rates will largely depend on population growth rates in excess of the national average. Some improvement in per capita income relative to the national average may occur as our labor force participation rate increases and wages and salaries are brought closer to the national average of per capita income, but we do not expect to equal or exceed the national average in the foreseeable future.

Since 1970, we have experienced an in-migration that has given the state a higher than average population growth rate. This phenomenon appears to be continuing and we anticipate that it will continue through 1980. Thereafter, we anticipate a decline in the rate of growth of population that will result in Tennessee achieving a rate of growth of output that is greater than the national rate but not by a large amount.

Our studies indicate that population growth is strongly affected by the rate of growth of employment. Relatively good employment opportunities tend to draw population from other states, while a poorer job growth rate will lead to a declining share of the U.S. population.

The anticipated slowing of the state's economy in the latter half of 1979 and slow growth in 1980 and 1981 will adversely affect the creation of new jobs. By 1981, we anticipate that this will have an impact on the rate of growth of Tennessee's population.

THE NATIONAL AND STATE OUTLOOK TO 1985

We are anticipating a period of relatively slow growth for the U.S. and state economies from now through 1985. We expect the rate of growth of the national economy to slow during the last half of 1979 in response to the current restrictive monetary policies of the Federal Reserve Board and the efforts of the executive and legislative branches to reduce the federal deficit.

Slow growth (of around 1.5 to 2.25 percent) is then expected for the state's economy in 1980 and 1981. Thereafter, we expect moderate growth rates of 3 to 3.5 percent through 1985 as the national government continues to exercise restraint in an attempt to maintain the stability of the dollar and to control the forces of inflation.

This slower growth is expected to result in a slower rate of job formation than we have experienced during the last decade, and we anticipate that our rate of growth in population will fall below the national average as it did during the 1950 and 1960 decades.

ENERGY DEMAND AND THE STATE'S ECONOMY

In light of increased concern over the role of energy in the economy, an energy sector was developed as an integral part of the Tennessee Econometric Model (TEM). This portion of the model involves some 31 equations designed to forecast: (1) energy use measured in conventional units, (2) energy use measured in common units (BTU's), and (3) energy prices. Consumption and prices are estimated for the following subsectors: electricity, gas, coal, gasoline and fuel

oil. The electricity and gas sectors are further sub-divided into residential commercial and industrial categories. The variables which enter into the electricity consumption and price equations are as follows:[1]

Dependent variables:

Total electricity consumption (excluding direct sales and sales to federal installations).
Residential electricity consumption (TECRES).
Commercial electricity consumption (TECC).
Industrial electricity consumption (TECI).
Average price of electricity.
Residential electricity price (TEPRES).
Commercial electricity price (TEPC).
Industrial electricity price (TEPI).

Independent variables:

Sum of residential consumption, (TECRES) commercial consumption (TECC), and industrial consumption (TECI).

Residential electricity price (TEPRES), residential gas price (TTGPRES), personal income (TPY001) and U.S. personal consumption deflator (UDPC).

Commercial electricity price (TEPC), gross state product (TGSP).

Industrial electricity price (TEPI), industrial gas price (TTGPIND), gross state product (TGSP), industrial electricity consumption in the previous period.

Weighted average based on subsector prices (see below) and sector consumption (see above).

Coal price (TCPR), residential electricity consumption (TECRES), residential electricity price in previous period.

Coal price (TCPR), commercial electricity consumption (TECC), commercial electricity price in previous period.

Coal price (TCPR).

The forecasting equations for each of these dependent variables (and the associated statistics) are reported in Appendix I. In all cases the value of the coefficient of determination is .980 or better.

Electricity sector consumption and price data for 1975 with projections to 1980 and 1985 are shown in Table 2. This projection is based on the December 15, 1978 forecast of TEM discussed above. We forecast a compound rate of growth (as shown in Table 3) of 3.1 percent in electricity consumption from 1975 to 1985. In terms of subsectors, the estimates are: residential consumption, 2.2 percent growth; commercial consumption, 3.0 percent growth; and industrial consumption, 4.2 percent growth. As can be seen from the table, we are estimating about a 10 percent compound rate of increase in electricity prices over the ten-year period. Among the subsectors, the variations in the rate of price increase are negligible.

It is apparent from Table 3 that we anticipate a decline in the rate of growth of electric consumption between 1980 and 1985 relative to the earlier 1975 to 1980 period. This lower growth rate is primarily a result of an expected slower average growth rate in the stat's economy in the later period. The year 1975 was a recession year and our output level was, at that time, considerably lower than the pre-recession level achieved in 1973.

Since 1975, we have experienced three years of rapid growth in GSP of 7.8 percent, 5.5 percent and 3.5 percent. Combining these rapid rates with the slower rates expected in 1979 and 1980, we expect to average better than 4 percent per annum over the five-year period. From 1980 to 1985, we expect to average about 3 percent growth per annum. Consequently, we would not expect the rate of growth in electric consumption to be as great in the later period.

Table 4 shows the elasticity of demand for electricity with respect to price and increases in real output or personal income. In general, we expect a 1 percent increase in state output to increase electricity consumption by 1.6 percent. However, this increase in consumption is tempered by price increases, since a 1 percent increase in price will result in a decline in electricity consumption of about one-half of 1 percent.

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[1] Unless otherwise indicated, variables represent Tennessee data.

CONCLUSIONS

In summary, we would like to emphasize the following points:

1. We anticipate real growth (as measured by gross state product) of 3.6 percent per year over the 1975–1985 decade and find this consistent with a growth in electricity consumption of 3.1 percent when price increases are taken into account. Indeed, as far as total energy consumption is concerned there has been some "uncoupling" of growth in real output and energy inputs in Tennessee since 1970 due to price increases, and we expect this to continue in the future. Net energy consumption per dollar of real GSP fell by 8 percent between 1970 and 1975, and we estimate a further 16 percent decline in this figure for the decade ending in 1985.

2. We are anticipating that energy prices will continue to rise at a pace considerably in excess of increases in the general price level. Our figures suggest a 10 percent average rate of increase in electricity prices while the deflator for gross state product is expected to increase at a rate of about 6 percent during the 1975–1985 decade. Coal prices play an important role in our forecasts of electricity prices. In light of the UMW/BCOA labor agreements signed a year ago which call for further rounds of substantial wage increase, and the fact that higher costs of surface mining associated with full compliance with the Surface Mine Act of 1977 have probably not been fully factored into the price of coal, there is intuitive support for the notion that electricity may continue to become more expensive relative to a representative bundle of other goods and services. Of course, as we move toward 1985 more of the electricity produced in Tennessee will come from nonfossil sources, and other factors may be of greater importance in explaining the price of electricity toward the end of the period.

3. As a final matter, we must urge that these projections be interpreted cautiously. The methodology of econometric model building for Tennessee has great strength to the extent that developments in this region are linked to the national economy, and to the extent that a requirement for internal consistency is imposed. There are limitations, however. Exogenous factors (a prolonged interruption of oil imports from Iran or a rapidly expanding national economy, for example) could upset our projections. Also, it should be remembered that these forecasts are based on historical structural relationships, some of which may have changed in recent years. We do, however, believe the underlying methodology is sound and that the forecasts can, properly qualified, be of value in a wide range of applications. Furthermore, this forecast is for the state of Tennessee alone and it may not be completely representative of the entire TVA region.

TABLE 1.—FACTORS AFFECTING PER CAPITA INCOME DATA FOR 1976 CALENDAR YEAR

Area	Per capita personal income	Percent of persons 25 years and older with high school education or less	Percent black	Percent of families with female heads, no husband present	Percent 65 years and over	Percent outside metropolitan areas	Percent of employed persons 14 plus whose primary job is in manufacturing	Percent of employed persons 14 plus whose primary job is in durable manufacturing	Percent of persons 14 plus who are employed
Northern Tier [1]	6,719	72.8	3.3	13.9	10.4	21.9	25.8	16.2	63.4
South [2]	5,668	73.8	18.1	13.7	10.5	44.5	20.5	9.5	61.9
East South Central [3]	5,156	78.3	20.5	14.5	10.5	55.0	24.1	11.9	59.9
Tennessee	5,305	77.5	16.4	14.1	10.4	49.9	25.3	11.2	62.2
Kentucky	5,414	79.7	8.7	12.7	10.6	56.8	20.3	11.6	57.6
Alabama	5,138	78.6	26.8	15.1	10.3	43.2	27.0	12.9	59.2
Mississippi	4,543	77.4	35.5	17.1	10.6	79.9	23.0	12.3	60.1
United States	6,403	70.7	11.5	13.4	10.3	31.3	21.4	12.3	63.8

[1] Northern tier consists of Wisconsin, Illinois, Michigan, Indiana, Ohio, New York, Pennsylvania, New Jersey, Massachusetts, Connecticut, and Rhode Island.

[2] South consists of East South Central States, Texas, Oklahoma, Arkansas, Louisiana, West Virginia, Virginia, North Carolina, South Carolina, Georgia, and Florida.

[3] East South Central consists of Tennessee, Kentucky, Alabama, and Mississippi.

Source: Calculated from U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, August 1978 and U.S. Department of Commerce, Bureau of the Census, Current Population Reports, series P-60, Nos. 110–112, various tables.

TABLE 2.—TEM ELECTRICITY CONSUMPTION AND PRICE PROJECTIONS

Variable	1975	1980	1985	1985÷1975
Electricity consumption, total (millions of kilowatthours)	42, 686	52, 442	57, 964	1. 358
Residential	22, 038	25, 849	27, 289	1. 238
Commercial	3, 516	4, 330	4, 719	1. 342
Industrial	17, 133	22, 263	25, 956	1. 515
Electricity price, average (cents per kilowatthour)	1. 99	3. 47	5. 19	2. 608
Residential	2. 07	3. 58	5. 41	2. 614
Commercial	2. 50	4. 35	6. 37	2. 548
Industrial	1. 78	3. 16	4. 74	2. 663

Source: Tennessee Econometric Model, Center for Business and Economic Research, College of Business Administration, the University of Tennessee, Knoxville.

TABLE 3.—TEM ELECTRICITY CONSUMPTION AND PRICE PROJECTIONS AVERAGE ANNUAL RATES OF GROWTH

[In percent]

Variable	Period		
	1975–80	1980–85	1975–85
Total electric consumption	4. 20	2. 03	3. 11
Residential	3. 24	1. 09	2. 16
Commercial	4. 25	1. 74	2. 99
Industrial	5. 38	3. 12	4. 24
Average electricity price	11. 76	8. 38	10. 06
Residential	11. 58	8. 61	10. 08
Commercial	11. 71	7. 93	9. 80
Industrial	12. 16	8. 45	10. 29

Source: Tennessee Econometric Model, Center for Business and Economic Research, College of Business Administration, the University of Tennessee, Knoxville.

TABLE 4.—ELASTICITY OF DEMAND FOR ELECTRICITY

Variable	Price	Total personal income or gross State product in constant dollars
TECRES	—. 4749	1. 6557
TECC	—. 2612	1. 3137
TECI	—. 6955	1. 6612
Weighted average	—. 5469	1. 6293

Source: Tennessee Econometric Model, Center for Business and Economic Research, College of Business Administration, the University of Tennessee, Knoxville.

APPENDIX I.—ENERGY SECTOR FORECAST EQUATIONS FOR ELECTRICITY CONSUMPTION AND PRICE

	R^{-2}	S.E.	D.W.	Period
(1) $\ln TECRES = 2.8479 - 0.4749 \ln (TEPRES/TTGPRES) + 1.6557 \ln (TPY001/UDPC)$ (9. 721) (−5. 744) (37. 936)	0. 985	0. 0696	1. 45	53–76
(2) $\ln TECC = -4.7711 - 0.2612 \ln TEPC + 1.3137 \ln TGSP$ (−16. 308) (−3. 778) (41. 664)	. 987	. 0522	1. 48	51–75
(3)[1] $\ln TECI = -6.0566 \times (1.0 - 0.4729) - 0.2489 [\ln (TEPI/TTGPIND) - 0.4729$ (−7. 543) (2. 748) (−2. 237) (2. 748) $\ln (TEPI_{-1}/TTGPIND_{-1})] - 0.3512 [DUMMEP - 0.4729\ DUMMEP_{-1}]$ (−11. 009) (2. 748) $+1.6612 [\ln TGSP^* - 0.4729 \ln TGSP^*_{-1}] + 0.4729 \ln TECI_{-1}$ (29. 295) (2. 748) (2. 748)	. 996	. 0398	1. 54	51–75
(4)[1] $\ln TEPRES = -0.0585 \times (1.0 - 0.5875) + 0.6254 [\ln TCPR - 0.5875 \ln TCPR_{-1}]$ (−0. 147) (3. 567) (14. 937) (3. 567) $-0.0970 [\ln TECRES - 0.5875 \ln TECRES\$^{1}] + 0.5875 \ln TEPRES_{-1}$ (−2. 084) (3. 567) (3. 567)	. 980	. 0356	1. 81	56–76
(5)[1] $\ln TEPC = 0.1744 \times (1.0 - 0.5903) + 0.5092 [\ln TCPR - 0.5903 \ln TCPR_{-1}]$ (0. 604) (3. 536) (17. 889) (3. 536) $-0.0843 [\ln TECC - 0.5903 \ln TECC_{-1}] + 0.5903 \ln TEPC_{-1}$ (−2. 082) (3. 536) (3. 536)	. 985	. 0250	1. 61	56–76
(6) $\ln TEPI = -1.4572 + 0.7217 \ln TCPR$ (−44. 802) (39. 172)	. 985	. 0376	1. 34	53–76

[1] Equation corrected using Cochrane-Orcutt technique.

Source: Tennessee Econometric Model, Center for Business and Economic Research, College of Business Administration, the University of Tennessee, Knoxville.

APPENDIX I

TVA is the source for data on the consumption of electricity (measured in kilowatt hours) sold through its distributors and the average price paid by consumers. The consumption of electricity is divided into three categories: residential, TECRES; commercial, TECC; and industrial, TECI. The price for these categories—residential, TEPRES; commercial, TEPC; and industrial, TEPI; are calculated by dividing the revenues received by category by the amount of consumption in that category. An average total price, TEPT, is also calculated. Excluded from the electricity data are direct sales by TVA and governmental sales. DUMMEP is a dummy variable representing the inclusion of the Memphis area into the TVA power service area.

PER CAPITA INCOME IN TENNESSEE

Senator SASSER. Dr. Goolsby, there was one statement in your prepared statement that I wanted to ask you about. I'll read it. You say, "It is unlikely that Tennessee will achieve a per capita income equal to the national average."

Dr. GOOLSBY. That's correct. There are certain factors within the State that indicate that our per capita income, although it's growing at a more rapid pace than that of the Nation, will not continue to grow at a more rapid pace, so that we will not exceed the national per capita average. Those factors are listed in table 1, which would indicate that we would probably have a lower per capita income continuously.

Senator SASSER. Well, now, is our rate of per capita income increasing any faster than our sister States in the Sun Belt?

Dr. GOOLSBY. I think probably not. Part of that's a base problem. Mississippi, for example, has the lowest per capita income in the Nation. Smaller absolute changes in per capita income are a larger percentage change for them, so when you have a smaller base, you would expect larger percentage changes. So, Tennessee is probably somewhere in the middle so far as the Southern States are concerned, with respect to the rate of growth of per capita income.

Senator SASSER. Well, I would like to ask you what you think Tennessee should do to bring our per capita income closer in line to the national average, and how dependent do you think consumption of electricity is on per capita income?

FACTORS AFFECTING PER CAPITA INCOME

Dr. GOOLSBY. Well, one of the factors that has led to more rapid growth in the State, I believe, is the lower cost of energy and the availability of energy. So, that is an important factor. Some other factors that contribute to a lower per capita income of the State are, first of all, the larger percentage of black people within the State, a lessening of the discrimination against black people in terms of employment and wage levels, would improve the per capita income of the State. Also, another factor is that the percent of the families headed by females in the State is higher than the national average. That would indicate that a lessening of discrimination against females in employment and wage levels would improve the per capita income within the State relative to the Nation. Also, the lower cost and availability of energy should lead to greater job

opportunities, thereby increasing the labor force participation rate in the State. The labor force participation rate is currently that of the Nation, so that if we can have a larger percentage of our population employed, that would of course, increase the per capita income of the State relative to the Nation.

Also, we could try to attract relatively high wage industry rather than low wage industry, and this would be an improvement.

Mr. MOORE. I might just add, Senator, the one other factor that Dr. Goolsby didn't mention is education, and representing the university we would like to emphasize that role as well.

Senator SASSER. Well, Dr. Moore, I appreciate you emphasizing that. I might say that your colleagues in the administration at the university do an excellent job of emphasizing that with the political leadership not only on the State level but on the Federal level.

Let me ask you one final question, Dr. Goolsby, as the quality of life increases in Tennessee and hopefully it will, and your prediction is it will although not dramatically. Three percent growth rate doesn't sound all that phenomenal to me. As the quality of life improves and per capita income continues to increase relative to what our per capita income is now, can't we expect a steeper increase in electrical consumption?

PRICE KEY FACTOR IN CONSERVATION OF ELECTRICITY

Dr. GOOLSBY. Well, sir, I believe that the consumption of electricity is largely related to the price of electricity; and if the price of electricity rises more rapidly than the price of other goods, then people will economize on electricity. They will burn more wood, coal, and other fuels rather than electricity. The price of electricity is, I believe, the key factor in determining whether or not new technology will be brought to bear on the conservation of electricity and so on. I'm anticipating higher prices of electricity, and that is why I expect conservation.

Senator SASSER. I notice that from your prepared statement. Of course, we can look at some figures which indicate that even with escalating electrical rates over the past 4, 5, 6, or 7 years, that consumption of electricity continues to go up fairly dramatically. What do we do, reach some golden mean where consumption falls off and we start looking for alternative sources?

Dr. GOOLSBY. Well, sir, as I indicate in my prepared statement, there has been a decline in the use of electricity per unit of State output. The output of the State is increasing, and the population is increasing and so on and so forth, and we are experiencing usage of electricity. However, relative to the production that we're bringing forth from the State, our consumption of other goods and services, it is declining somewhat, and if the price goes up more dramatically, then that decline will be more rapid.

Senator SASSER. Well, looking at your projected increases, some of them look pretty dramatic to me.

Dr. Goolsby, thank you very much for giving us the benefit of your views this morning.

Dr. Moore, which one of your colleagues is next?

Mr. MOORE. Mr. Roger Carlsmith from Oak Ridge National Laboratory.

Senator SASSER. All right, sir. Mr. Carlsmith.

STATEMENT OF ROGER S. CARLSMITH, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENN.

Mr. CARLSMITH. Thank you. We've already heard this morning of several estimates that have been made concerning future electricity use by TVA customers. The reliability of these estimates is important. On the one hand, underestimating the requirements can lead to blackouts, economic dislocations, and various kinds of personal hardship. On the other hand, overestimating the growth in demand would cause wasteful expenditures on new generating facilities and as a result needless increases in electric rates.

IMPORTANCE OF ACCURATE FORECASTING

The forecasts by different analysts give quite a range of results. This should not be surprising to anyone. Forecasting is not an exact science, even if perfect information were available. In fact, there are big gaps in the information needed to analyze electricity consumption accurately, as has been discussed by several of the previous speakers.

Perhaps even more important, electricity use can be increased or decreased through the policies adopted by TVA or other Government bodies. There is a long list of policies that will tend to shape energy use, including environmental restrictions, administrative allocation of scarce fuels, energy taxes and subsidies, and research programs on alternate sources of energy.

In my statement I want to illustrate these points by first presenting some results from an econometric model that's been developed at the Oak Ridge National Laboratory, and then to compare these results with some of the others.

OAK RIDGE NATIONAL LABORATORY STATE LEVEL ELECTRICITY DEMAND MODEL

The model I will discuss is the Oak Ridge National Laboratory State Level Electricity Demand Model. It uses a comprehensive data base extending from 1955 to 1976, and uses econometric techniques to identify the contributions of each of several dozen causative factors.

The results for the residential sector show that important variables include electricity prices, natural gas availability, population, income, and climate. In the commercial sector, electricity price, population, and income were important; while in the industrial sector, the value added in manufacturing and electricity price were the important variables.

FORECASTS FOR TVA SERVICE AREA

We used the model to obtain forecasts for each of the States in the east south-central region. We then combined these into a single TVA area forecast. We looked at three scenarios with respect to different assumptions as to future fuel costs. Since the price of electricity de-

pends strongly on fuel costs, and the price of electricity in turn is one of the most important factors influencing electricity demand, this procedure gives some idea of the sensitivity of our forecasts to the assumptions that we made. Thus, we ran a base case scenario in which we assumed electricity prices to rise at 6 percent per year from 1976 to 1990, a high-price case in which electricity prices rise 7.9 percent per year over that period, and a low-price case in which prices rise only 4.3 percent.

Our results can be summarized as follows. For the base case, electricity demand rises from the 1976 level of 118 billion kilowatt-hours per year to 213 billion kilowatt-hours per year in 1990, or a growth rate of 4.2 percent per year. The high-price and low-price cases give demand growth rates ranging from 3.5 percent per year to 4.9 percent per year.

COMPARISONS WITH OTHER FORECASTS

Some idea of the range of uncertainty can be obtained from these three cases. However, it should be kept in mind that the three cases were all obtained with the same model and considered only one source of uncertainty, the electricity prices. In particular, this model does not allow for any reductions in demand caused by new technologies in conservation or solar energy.

A broader perspective may be gained by comparing the entire range of forecasts made recently by several different investigators. In my prepared statement, I've given the numbers for the results that we got with this Oak Ridge model, the results that GAO presented in the report that's been discussed several times here this morning, TVA's estimates in 1977, and some recent TVA estimates.

I would summarize these by saying that in the horizon year of 1990, in which I made the comparison, the estimates from the Oak Ridge model were virtually identical with the estimates presented by GAO in their report. In turn, these sets of estimates were all lower than TVA presented in 1977. On the other hand, TVA's most recent estimates, which cover a wide range of cases, range from a high—what they called their highest estimate, which is in the same range with these others—down to a distinctly lower value of about 2.2 percent growth rate over the period.

CONTINUED GROWTH IN TVA'S ELECTRICAL DEMAND

Well, what does all this mean? I'd like to summarize by giving a couple of main conclusions that I would draw from these comparisons. The first is that the forecasts reviewed here, including Mr. Goolsby's which was not included in my paper, all predict continued growth in TVA's electrical demand. I think that this is a significant point, in that one sometimes hears people saying that it might be possible to have no growth—no further growth in demand; and that sort of viewpoint does not seem to be supported by any of the detailed analyses that have been made. If we disregard TVA's 1977 estimates as having been superseded by the more recent TVA forecasts, we still have estimates of annual growth rates that range from 2.1 percent per year to a high of 4.8 percent per year. All of them fall within that range.

And second, all of these forecasts consider the important role of economic and demographic factors in influencing the levels of electricity use. Ase a result, none of the forecasters is predicting growth rates as high as the 7 percent per year that has been considered sort of standard in the electric utility industry until recently.

Thank you.

Senator SASSER. Thank you, Dr. Carlsmith.

[Mr. Carlsmith's statement follows:]

PREPARED STATEMENT OF R. S. CARLSMITH, CENTRAL MANAGEMENT DIVISION, OAK RIDGE NATIONAL LABORATORY; AND H. D. NGUYEN, R. C. TEPEL, AND J. L. TRIMBLE, ALL OF THE ENERGY DIVISION, OAK RIDGE NATIONAL LABORATORY

ELECTRICITY DEMAND FORECASTS FOR THE TENNESSEE VALLEY AUTHORITY SERVICE AREA [1]

Introduction

Several recent estimates have been made concerning future electricity use by TVA customers. The reliability of these estimates is an important question and deserves careful attention. On the one hand, underestimating the requirements can lead to blackouts, economic dislocations, and personal hardship. On the other side, overestimating the growth in demand would cause wasteful expenditures on new generating facilities and needless increases in electric rates.

Forecasts by different analysts give a wide range of results. This is not surprising. Forecasting is not an exact science, even if perfect information were available. In fact, there are big gaps in the information needed to analyze electricity consumption patterns. For instance, shifts in population and relocation decisions by industry will change the picture. Perhaps even more important, electricity use can be increased or decreased through the policies adopted by TVA and other governmental bodies. There is a long list of policies that will tend to shape energy use including environmental restrictions on various fuels, administrative allocation of scarce fuels, energy taxes and subsidies, research programs on alternate energy sources, and public awareness programs. Those who prepare forecasts as well as those who use them need to keep constantly in mind both the uncertainties and the fact that we control some aspects of our future. In the following sections we will illustrate these points by first presenting some results from an econometric model developed at the Oak Ridge National Laboratory and then comparing these results with others.

The ORNL SLED model

The ORNL state level electricity demand (SLED) model has been developed for the Nuclear Regulatory Commission by W. S. Chern and co-workers [2] as part of an extensive investigation into the factors that influence electricity demand. It draws on a comprehensive data base extending from 1955 to 1976 and uses econometric techniques to identify the contributions of each of several dozen causative factors. The model uses simultaneous equations to estimate electricity price and electricity demand for the residential, commercial, and industrial sectors. The equations were estimated for each of the nine census regions using state-level annual data.

The results for the residential sector show that important variables include electricity price, natural gas availability, population, income, and climate. In the commercial sector electricity price, population, and income were important while value added in manufacturing and electricity price were important to industrial electricity demand.

Forecasts for TVA service area

We used the model to obtain forecasts for each of the states in the East South Central region. These were then combined into a single TVA area fore-

[1] Research sponsored by the U.S. Department of Energy under contract W-7405-eng-26 with the Union Carbide Corp.

[2] W. S. Chern, R. E. Just, B. D. Holcomb and H. D. Nguyen, "Regional Econometric Model for Forecasting Electricity Demand by Sector and State," Oak Ridge National Laboratory Report ORNL/NUREG-49 (October 1978).

cast by assuming that TVA would continue to supply the same percentage of the total demand for each state as it did in 1978. We looked at three scenarios with different assumptions as to future fuel costs. Since the price of electricity depends strongly on fuel costs and is one of the most important factors influencing electricity demand, this procedure gives some idea of the sensitivity of our forecast to the assumptions we made. Thus we ran a base case scenario in which electricity prices rise 6.0 percent per year from 1976 to 1990, a high-price case in which electricity prices rise 7.9 percent per year over the same period and low-price case in which prices rise 4.3 percent.[3]

Table-1 shows the resulting rate of increase in electricity demand for each sector and scenario.

TABLE 1.—GROWTH RATES IN TVA ELECTRICITY DEMAND FOR 1976–90

[Percent per year]

	Residential	Commercial	Industrial	Total
Base case	4.0	5.1	4.1	4.2
High-price case	3.2	4.2	3.6	3.5
Low-price case	4.7	5.9	4.9	4.9

These results can be summarized as follows. For the base case electricity demand rises from the 1976 level of 118 billion kWhr per year to 213 billion kWhr in 1990, or a growth rate of 4.2 percent per year. The high-price and low-price cases give demand growth rates ranging from 3.5 percent per year to 4.9 percent per year.

Comparisons with other forecasts

Some idea of the range of uncertainty can be obtained from the three cases presented above. However, it should be kept in mind that these three cases were all obtained with the same model and considered only one source of uncertainty—electricity prices. In particular, the ORNL SLED model does not allow for any reductions in demand caused by new technologies in conservation or solar energy.

A broader perspective may be gained by comparing the entire range of forecasts made recently by several investigators. Such a comparison is given in Table 2 and in Figure 1.

In Table 2 the three ORNL–SLED forecasts have already been described. The two GAO forecasts have recently been published,[4] based on analysis that was done in 1977. The TVA (1977) forecast is also described in Ref. 3 along with the methodology that was used to produce it. The TVA (1978) forecasts are from recent unpublished estimates by the TVA Office of Power and represent the extreme high and low estimates from a larger number of projections made by TVA.

TABLE 2.—FORECASTS OF TVA POWER SYSTEM REQUIREMENTS

[Billions of kilowatt hours]

Year	TVA (1977)	TVA (1978) low	TVA (1978) high	GAO[1] low	GAO[1] high	ORNL–SLED[1] high-price	ORNL–SLED[1] base	ORNL–SLED[1] low-price
1976	118	118	118	118	118	118	118	118
1980						136	141	145
1985	192			176	188	162	174	185
1990	245	159	220	[2] 192	[2] 229	193	213	235
2000	341			223	311			

[1] Calculated values multiplied by 1.072 in 1977 and 1.079 in 1990 to convert to net system requirements.
[2] Interpolated values.

[3] Growth rates are with respect to current dollars. To convert to real dollars subtract 3.6 percent per year assumed average inflation rate.
[4] United States General Accounting Office, "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority," EMD–78–91 (Nov. 29, 1978).

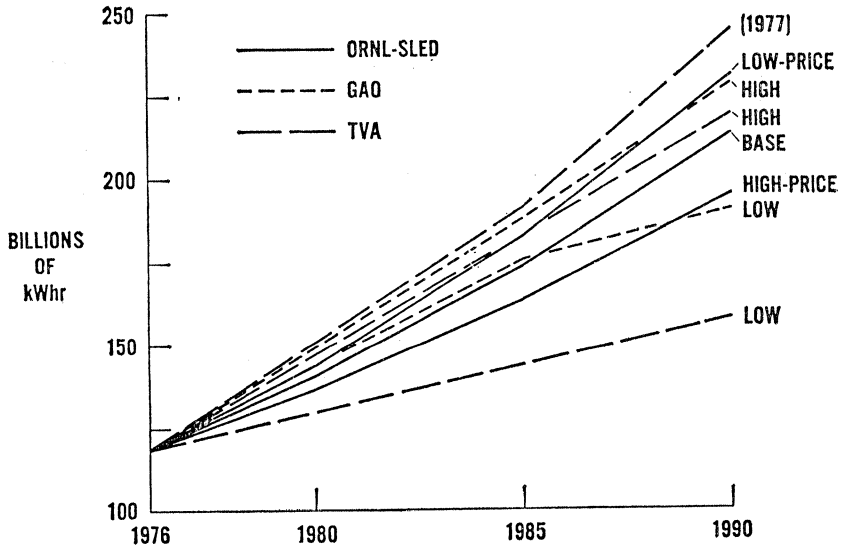
Conclusions

1. The forecasts reviewed here all predict continued growth in TVA's electrical demand. However, there is clearly a large measure of uncertainty in the magnitude of that growth. If we disregard the TVA (1977) estimates as having been superseded by TVA's more recent forecasts, we still have estimates of annual growth rates ranging from 2.1 percent per year (TVA 1978 low case) to 4.8 percent per year (ORNL–SLED low-price case).

2. All of these forecasts consider the important role of economic and demographic factors in influencing the levels of electricity use. As a result, none of the forecasters is predicting continuation of the 7 percent per year growth that has until recently been considered axiomatic in the electric utility industry.

Fig. 1

FORECASTS OF TVA POWER SYSTEM REQUIREMENTS



EFFECT OF PRICE ON ELECTRICITY CONSUMPTION

Senator SASSER. Mr. Carlsmith, you mentioned that one of the most important factors influencing electrical demand is the price of electricity, I think?

Dr. CARLSMITH. Yes, sir.

Senator SASSER. I touched on this briefly with Dr. Goolsby just a moment ago, but pointing out that in the past 13 or 14 years the residential price of electricity has increased by more than 200 percent, in current or real dollars that's in excess of 100 percent.

Now, the models for forecasting future demand seem to assume that, and we're hearing it here today, that such increases in price would lead to decreases in residential consumption. However, I'm told that in 1965 the average TVA residential customer used 10,381 kilo-

watts of electricity, but last year in the face of electrical rates which have at least doubled, or I think really more than that, last year the average electrical residential consumer in the Tennessee Valley area used 16,250 kilowatts. Now, this is an increase of more than 60 percent in a time when electrical rates have escalated substantially.

Now, my question is, what evidence, directing it to you, what evidence do you see that consumption will decrease as electrical rates go up?

ECONOMIC GROWTH'S EFFECT ON CONSUMPTION

Dr. CARLSMITH. Yes, sir. All of the things that you stated are absolutely correct. It is true that electricity prices are an important factor, one of the most important factors in determining demand, but you have to keep in mind that there are also some other important factors, which include population, incomes, the amount of industry that is located in the area. All of these have been increasing during the period that you were referring to, and all of them are projected to continue to increase during the next couple of decades. So, the net result in terms of electricity demand will come from the effect which the price increases will have to make demand go down, and these other factors that all tend to make it go up. The models that we've been discussing, and the calculations that we've been discussing this morning, all take the sum total of these effects into account, and as I indicated, all tend to come out with the same sort of result: that electricity demand will continue to increase but not at as fast a rate as it has in the past.

Senator SASSER. Well, thank you very much, Mr. Carlsmith. I might say that we're very pleased today to have Dr. John Gibbons. I'm delighted that he could join us and I know that Dr. Gibbons is very knowledgable in the area we're discussing today and that is projecting energy demand of the future, and John, I wonder if you would care to comment or give us your views at this time.

STATEMENT OF JOHN H. GIBBONS, UNIVERSITY OF TENNESSEE

Dr. GIBBONS. Thank you, Senator. I have not prepared testimony in the interests of time, or in the conviction that my predecessors today would give you a complete accounting of the analyses that lay behind the sums of the GAO work, as well as the independent work at Oak Ridge and at the university. However, I would like to, perhaps, add a few comments to those statements made this morning.

COMPARATIVE COSTS OF POWERPLANTS

First of all it seems to me important for us to remember that the price of a new powerplant in the old days used to be less than the price of an existing powerplant. The economists would say that the marginal cost of additional electricity was lower than the average cost that was already on the system.

Now, that situation turned around in the early 1970's and it means that we must be even more careful than in earlier times about our plans for expansion, simply because of the increased cost of an error that might lead us to over capacity. Nowadays I think we could defend the

case that over capacity or an excess of power is undesirable because of the increased cost of keeping those plants on line.

Senator SASSER. You might push that microphone away from you just a little bit, John.

Dr. GIBBONS. It's just as costly as an undercapacity or a shortage of electricity.

Senator SASSER. All right.

NATURAL GAS IN COMPETITION WITH ELECTRICITY

Dr. GIBBONS. The second point is that we're faced with moving targets. Targets that are moving faster and with greater uncertainty than, perhaps, ever before. For example, there are moving estimates of energy supplies and certainly of energy prices; in the gas area alone there's a great deal of uncertainty about how much more gas may come forward at higher prices, but an increasing optimism that a great deal more gas may come forward at higher prices. I would remind you that even if gas rose to $5 per million Btu, a considerable rise, it would still be considerably less expensive than electricity at 3 cents per kilowatt hour; which is about where we are now in TVA country.

As, for instance, gas becomes more available at the higher price it may well result in competition for electricity, even here in the Tennessee Valley.

There are also uncertainties as to the extent to which energy is substitutable. How far, for instance, can one substitute more insulation or a better designed refrigerator for electricity and come out ahead in terms of consumer cost? Also, there are uncertainties as to Federal actions such as tax credits. The potential economic viability of solar heated water, even in the TVA area, is now strongly effected by some of the new tax credits that are a result of the National Energy Act. Uncertainties also exist with regard to the future course of inflation and that comes to roost on the issue, for instance, of the bonded indebtedness ceiling for TVA.

PROJECTION METHODOLOGY FAVORED OVER FORECASTING

The third comment I would like to make is to again call to your attention the difference between forecasting, which is the statement of what is most likely, compared to projections which is a statement of "if you assume this, then that will probably happen." It is in this latter mode of making projections, it seems to me, that we're much more suited in this new era of uncertainty. In that regard, I'm very pleased that TVA's recent moves toward using projection methodology rather than a single forecast.

SMALLER FAMILY SIZE IMPACT ON ENERGY DEMAND

The fourth point comes from reflection on the service I've had over the last several years on a committee of the National Academy of Sciences, which examined on a national basis the demand and supply projections for the Nation all the way out to the year 2010. In the

course of that work, it becomes much more clearly understood that the trends toward smaller family size, the consequent slowdown of increase in our labor force, and changes in social patterns will in the long run, affect our energy demand in a very significant way.

ENERGY CONSERVATION SENSITIVE TO COST

Additionally, and most importantly, perhaps, was a convergence of the ideas, and in fact of the results of the analyses carried out on the one hand by economists, and on the other hand by engineers. The outcome of this convergence of opinion is that conservation, in place of which I prefer the expression "increased productivity of energy," is highly sensitive to energy price. That is, as energy price moves upward, it is very cost effective to do something about it rather than continuing to buy the same amount of energy. In fact, in many instances the total cost of an amenity, whether it be a refrigerator of a certain size, an automobile of a certain quality, or a heated house, can actually be decreased in actions that cause it to use less energy. In this sense, in this kind of move toward higher productivity of energy, we find these actions to be anti-inflationary; because the amenity is acquired for a lower total cost.

GAO's projections for TVA, and also TVA's own projections are very compatible with the results that were arrived on a national basis through this academy study. There are much more detailed national studies that are fully compatible with these particular regional studies, and those all have the same bottom line. That the future demand growth for energy based on sensible economic reasons and actions will be much slower than the demand growth that obtained during the 1950 to 1970 time frame, but the changes will come slowly, because they mostly represent changes in the characteristics of our capital stock, rather than changes in the use of the existing stock.

TVA BORROWING AUTHORITY

With respect to TVA's request for increased debt limit, I would make two short observations. One is that a conservative appraisal of future inflation unfortunately now means that a higher debt limit will be required, even if real costs don't change. Secondly, that actions to keep demand growth for new central powerplants, and the accompanying higher energy price that would come if we had to build those plants, in check will also cost money. It won't come free; however, it will mean less money than otherwise would be required to expand and build those additional plants. That is, we're moving our investments from building more central powerplants, or at least a portion of those investments, to taking actions that enable us to provide the amentities without those plants. In the process we can save ourselves money.

Finally, I wish to applaud TVA's rapid movement over the last couple of years, toward regaining its national leadership as a yardstick for the Nation.

We should hope that TVA will also mount projects of national significance as well as regional significance; where it makes good economic sense to the consumers in the region, these projects should be based, I believe, on internally generated resources and through borrowing. In

doing this we can help hold down our own electricity prices. In other instances of national self-interest, Federal funds should be provided, and I believe, that the Authority in concert with other resources and expertise in the region has now the capability to play an effective comprehensive and even central role in the national energy effort.

Thank you.

Senator SASSER. Well, thank you very much, Dr. Gibbons, for that very interesting and perceptive statement.

Dr. MOORE. We have one more panelist, Senator Sasser, who may have some observations to make, William Chandler of the University of Tennessee Environment Center.

STATEMENT OF WILLIAM CHANDLER, UNIVERSITY OF TENNESSEE ENVIRONMENT CENTER

SPEEDUP CONSTRUCTION TO PREVENT COST OVERRUNS

Mr. CHANDLER. Senator, I would like to just reiterate one point made by Robert Bohm, regarding the possibility of reducing the amount of time required for constructing these powerplants. Reduction of this time could possibly help reduce cost overruns, which was one issue he raised earlier. Reduction of this time may be possible because the construction of the industrial cogeneration powerplants requires only 3 to 5 years, compared with 9 to 12 years for large central station generating plants.

As the General Accounting Office pointed out more than 5,000 MW of potential capacity exists in the TVA region today, so that exploitation of this potential could reduce power costs of the overall energy demand as well as add to the flexibility of TVA's operation.

Senator SASSER. Thank you.

Dr. Moore, I wish to express my appreciation to you and your colleagues from the University of Tennessee and from Oak Ridge National Laboratories for the light that you have shed on this subject for me, and I think for others today.

We're in your debt for appearing here, and I wish to express my gratitude, and I will convey many of the observations that you have made here today to my colleagues on the Senate Budget Committee as we consider this matter that we're having a hearing about today, and also to my colleagues on the Appropriations Committee.

Thank you very much. We have had a number of requests from public witnesses to present testimony at this hearing, and we've undertaken to hear from all of them, or will undertake to hear from all of them later; but yesterday I learned for the first time that the Tennessee Energy Authority desired to testify. Public witnesses have been scheduled to testify beginning at 2:45 during the afternoon session. However, a Mr. Ed Spitzer of the Tennessee Energy Authority is here. He has pressing business which is going to require that he return to Nashville prior to 2:45, so in an effort to accommodate Tennessee Energy Authority, I wish to allow him to testify at this time.

Mr. Spitzer if you would come forward, and we're asking, I might say, Mr. Spitzer, all public witnesses if at all possible to confine their remarks to 10 minutes.

STATEMENT OF ED SPITZER, TENNESSEE ENERGY AUTHORITY

Mr. SPITZER. Thank you, sir. Senator, I appreciate the opportunity to be here and the courtesy that you have extended me.

$30 BILLION CEILING PROVIDES TVA MORE FLEXIBILITY

I would like to take a very positive position right at the very beginning to state that if the $30 billion is to be used to develop generating capacity for the valley, that we heartily endorse it.

This is flexibility that the board needs, and I have been assured by both David Freeman and Dick Freeman just before this meeting that that certainly is their intent, that this would only be used for generating capacity in the valley.

Now, there is a single unifying reason modern society generates electrical energy, and that's to create and maintain employment. Without electricity the wheels of commerce and industry could not turn, nor could governments or systems of individuals and collective services be operated.

Society raises money, either by saving or borrowing, and invests in adding generating capacity so that economy can move ahead. In Tennessee this process has been efficiently and methodically handled by a very special Federal corporation, Tennessee Valley Authority.

INDUSTRIAL GROWTH DEPENDENT ON AVAILABILITY OF ENERGY SUPPLIES

When we get to discussing power projections these can be self-fulfilling prophesies that what is available will be used. If there's not enough, we won't use it, if there's too much, we tend to find ways to use it.

I think that industrial growth is dependent on that availability. I think that as you look at some of the things that have been said here this morning, such as costs being a factor; we have seen in other areas of energy, such as natural gas, the intrastate gas of the Gulf States was much, much higher priced than natural gas in other States; and yet industry flocked to those States to utilize the reliability of that natural gas, as opposed to the price of it.

SOLUTION OF ENERGY PROBLEM POLITICAL DECISION

Now, when we start talking about projections and forecasts, and be it done by an economist, or an engineer, I think that much more of our forecasts are done politically, than they ever are by technology and things of that sort. The solutions to the energy problems will be political decisions and not technological problems. They cannot move that rapidly; but when we look at other forms of energy, when we look at natural gas, when we look at coal, when we look at oil, and we see that we do not know where these supplies—how they're going to vary. We can get all sorts of projections. We hear projections that we get 75 percent of our energy from oil and natural gas, and those are being rapidly depleted. How much of that will have to switch to coal and nuclear and become electrical energy, and how much of this do we have to have available? These are projections that are very difficult to make.

TVA'S DISTRIBUTION OF ELECTRICAL ENERGY

But, one of the big concerns that we have in Tennessee is other Federal agencies, such as the Department of Energy, and the Federal Energy Regulatory Commission, and their power over the Tennessee Valley Authority, their ability to order them to wheel power to other parts of the country, their ability to order them to expand the service area. Now, there are sections of the country that, they don't want the power stations in their section of the country. They don't want the social economic impact of construction. They don't want to finance it. They don't want the pollution that comes from it, and they certainly don't want the radioactive wastes; but they do want that electrical energy, and I think that they would like to import it from the people of the valley. I think they must figure that we're sturdier people down here and can withstand these things better. It's almost as though they want to bring it in from the colony, and I have seen this happen. The Gulf States are almost colonies of the Northeast when it comes to natural gas and oil. I don't want us to have the same thing happen in electrical energy.

TVA ROLE IN EMERGENCY ENERGY SITUATIONS

Now, I must say, emergencies we understand, and we are prepared to—you know, we are the Volunteer State, and we support our sister States and our Nation, but we need to look at what are emergencies. Are they peak period today, are they a weeklong cold snap, or could an emergency be a 10-year period in which we just didn't build generating capacity somewhere else, and we have to export it to them.

These are the type of things that are very serious to us, and as Jack Gibbons so well put that it cost a lot more money to deliver a kilowatt of electricity from a new plant, than it does one that's 10, 15 years old.

Now, if we're going to be asked to build new plants to ship that electricity out of here, but roll in the pricing first, that means we're not only sending electricity out, we're going to be sending our money out, and these are concerns that will be controlled politically. Not by projections or forecasts, and they are very serious to the valley.

Now, the people of the valley have no input into this. We have a board of directors that will control this for us, the TVA board, but the voters do not put them there. Our Public Service Commission has no control over them, these are people that we elect. Our Governors have no input, as to exactly what's going to happen.

Senator SASSER. I'd say that Senators have little input too, sometimes, Mr. Spitzer.

Mr. SPITZER. As advisory role, yes.

Senator SASSER. OK, I said little input.

MORE LOCAL AUTONOMY IN OPERATION OF TVA NEEDED

Mr. SPITZER. But, we appreciate, you know, these power estimates that TVA is making up, and we appreciate what GAO is making, but you know, if you're wrong the people of the valley are going to pay the bill, and they can't throw the rascals out.

Now, you can replace Public Service Commissioners, you can replace legislators, you can replace Governors, but you cannot replace TVA

people, and you cannot replace GAO's estimates. That's just the way it happened. All the people of the valley are doing is paying the bills. They do not have any input into this. They will not have any input as to whether the power is wheeled out of the valley, they will not have any direct say-so as to whether that service area is going to be expanded, and these are serious concerns on the future debt limit of the valley. When you think of how little input we have into it, and I say this facetiously, but people in Boston have been known in the past to have had tea parties for lesser offenses; but when we see that these Presidential appointments are made, and there are three people there who have this control, the Senate confirms them to 9-year terms of office. Those three people have absolute power. They are a troika, and we have in the valley, we'll shortly have a veritable energy oasis, and that oasis will be in their control. They have the ability to make this area a highly industrial area with a high per capita income, or they have the ability to make us an agricultural State, or they have the ability to select an area in between where they think the quality of life is best for us, and develop it to that point.

EXEMPT TVA AREA FROM NATIONAL RATE SETTING

That's power that our Governors in this area do not have, that our legislative bodies do not have. But, I repeat, if this is to be used in the valley we certainly endorse it, but if it is to be used outside of the valley, then there are some requirements that I think we should insist on. I think that if it is going to be exported, that there should definitely be incremental pricing; that is essential to us. I think that if we are going to be supplying electrical energy to other parts of the Nation, then I think that we should be exempt from national ratesetting. Now, we don't have national ratesetting in electricity, but if you look at other forms of energy, you do in natural gas. We do in oil, and I assure you that there are people looking at the idea that they would sure like to average out with the Tennessee Valley area, and that's serious to us.

INCREMENTAL PRICING

I think that we should have some way that the people of the valley are represented on that board of TVA, and I also think that if that power is to be shipped out and there is incremental pricing, I think that there should be some method of directing funding to the States of the valley in proportion to the power sold in the TVA area so that we could develop other forms of energy so that we can develop some of these soft forms of energy, such as solar or recycling of waste, or electric cars or biomass, the use of reject heat or the conversion of coal to methanol or gasoline.

We don't want to become indentured servants, and that, sir, concludes my remarks, and I thank you very much.

TVA'S BORROWING AUTHORITY

Senator SASSER. Well, thank you, Mr. Spitzer. I gather that the thrust of your statement is that you would be in favor of lifting the debt ceiling?

Mr. SPITZER. Yes, sir.

Senator SASSER. But you would be in favor of putting the caveat on it that the additional power to be generated would be consumed here in the Tennessee Valley area except in time of perhaps emergencies in other areas?

Mr. SPITZER. That is right, and we're concerned that those issues are thority Board of Directors, and I thought I saw his fellow director, Mr. Richard Freeman, there.

Senator SASSER. Thank you, Mr. Spitzer.

We'll recess until 2.

[Thereupon, the hearing was recessed.]

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AFTERNOON SESSION

Senator SASSER. The hearing will come to order, and I'd like to welcome now Chairman David Freeman, of the Tennessee Valley Authority Board of Directors and I thought I saw his fellow director, Mr. Richard Freeman, there.

Mr. RICHARD FREEMAN. I'm going to stay in the back row.

Senator SASSER. Chairman Freeman, if you'd be kind enough to introduce your colleagues and make any statement you would wish to make, and then we'll get into their statements.

STATEMENT OF S. DAVID FREEMAN, CHAIRMAN, BOARD OF DIRECTORS OF THE TENNESSEE VALLEY AUTHORITY, ACCOMPANIED BY HUGH G. PARRIS, MANAGER OF POWER; ROBERT S. HEMPHILL, JR., DIRECTOR, DIVISION OF ENERGY CONSERVATION; LYNN C. MAXWELL, ASSISTANT CHIEF, ANALYSIS BRANCH, DIVISION OF POWER UTILIZATION; LEON RING, GENERAL MANAGER; JIMMY CROSS, CHIEF, STRATEGIC PLANNING BRANCH; AND BILL WILLIS, ASSISTANT TO THE MANAGER OF ENGINEERING, DESIGN, AND CONSTRUCTION, ALL FROM TVA

Mr. FREEMAN. Thank you, Mr. Chairman. I am accompanied today by, on my right Hugh G. Parris, our Manager of Power and our principal witness; Robert S. Hemphill, Jr., on my left, the Director of our new Division of Energy Conservation; Lynn C. Maxwell, Assistant Chief of the Analysis Branch, Division of Power Utilization; next to Mr. Hemphill is Leon Ring, our General Manager; then Jimmy Cross, Chief of our Power Strategic Planning Branch; and Bill Willis, Assistant to the Manager of Engineering, Design, and Construction. All of us are here to present to you this afternoon a crucial item for TVA and for the Tennessee Valley.

ECONOMIC GROWTH IN TVA REGION

In examining the question before us Mr. Chairman, it is essential that we consider the unique relationship of TVA to the Tennessee Valley region. TVA has a special responsibility which sets us apart

from most Federal agencies. TVA has been and will continue to be a principal factor in the economic and social well-being of this region. Our role as a supplier of electric power is central to TVA's regional development responsibility. Congress placed upon TVA the special responsibility to supply the electric energy needs of the region at the lowest feasible rates. And as you will recall from confirmation hearing, Senator Sasser, that was a point which you impressed upon me quite vividly. We take this responsibility quite seriously. We are projecting rapid economic growth in this Valley. We are projecting electric rates that are no longer a part of a double-digit inflation, and we are also projecting a very aggressive conservation effort.

INCREASE IN DEBT CEILING A NECESSITY

The proposed $15 billion increase in TVA's debt ceiling is vital to TVA's discharge of the responsibilities it has as a regional economic developmental agency and as a supplier of electric power. The number represents our best judgment with respect to the amount of borrowing authority necessary to meet these responsibilities over the next 5 years. Now we all know $15 billion is a whale of a lot of money. Perhaps it might be helpful to take a look at the $15 billion figure with the effects of inflation removed. If viewed in terms of 1975 dollars, when we had an increase of $10 billion, it is roughly equivalent to $10.2 billion. In terms of 1970 dollars it is the equivalent of $7 billion. The point that I'm trying to make is that while the sum is great, the buying power is not much different from the two previous requests the TVA board made at 5-year intervals for increases in our ceiling.

The witnesses to follow will present the detailed estimates to support our requests. But before we go into these details, I'd like to make three basic points:

TVA SELF-SUPPORTING AGENCY

First, TVA is not asking the Federal Government for money. This request will permit us to move forward with plans for the future, to borrow money that will be repaid on the credit of our ratepayers. The Federal Government incurs no obligation for TVA borrowing. The timing of this planning and the capability to act in a timely manner are just vital for an electric power system. The decisions on our desks today are decisions that affect this valley in 1990 and 1992. We now live with a leadtime of 10 to 12 years in providing for the region's electric power supply.

Second, TVA is planning for a prosperous future, not a "no growth future." A prosperous future assumes a growing demand for electric enregy used with conservation, not wastefully, but necessary if the economy is to grow. In a sense the ceiling on our debt limit is a ceiling on the Valley's growth.

INFLATION IMPACT ON CONSTRUCTION PROJECTS

Third, we recognize that TVA powerplants presently under construction are costing more than they were originally estimated; however, the experience of TVA is better than, and certain parallels that

of every large construction project in the Nation. We are aggressively striving for improvement.

The central fact is that inflation has eroded the purchasing power of the dollar to the point that we need additional borrowing authority to complete the powerplants under construction. We cannot order any new capacity without such authority, and we need to be in a position to place such orders at any time.

Senator, I have engaged, personally, in the art of projecting energy demands for the future and I think that everyone in this room knows that it is an uncertain art and that there is room for differing judgment. Demands for electric power are going to reflect the growth of our economy and no one can be absolutely sure what that growth will be. And they will also reflect the success of our conservation efforts. Under our utility responsibility we must plan for a reasonable measure of optimum growth. If our estimates for the future do not materialize, the worst that can happen is that we will not have to borrow the money as soon as we otherwise would and we won't have to come back to the Congress for 6 or 7 years rather than 5 years. But if we don't get this essential legislation, economic growth in the Valley will be halted. We believe the issue is clear and the need is urgent. We respectfully seek your all-out support.

The next witness will be Mr. Hemphill, who will briefly summarize his testimony and then Mr. Parris will take over.

Senator SASSER. Mr. Hemphill.

STATEMENT OF ROBERT S. HEMPHILL, JR., DIRECTOR, DIVISION OF ENERGY CONSERVATION, TENNESSEE VALLEY AUTHORITY

Mr. HEMPHILL. Thank you very much, Senator Sasser.

I'd like to submit the written testimony for the record and only add a couple more quick points to summarize that.

CONSERVATION AND SOLAR PROGRAMS

First of all it seems reasonably clear to those people who have analyzed it carefully that conservation and solar programs are, in fact, quite attractive. The reasons are fairly simple. They are generally cost effective. Data we have from homes we have built to our super saver standards indicate that homeowners living in those homes save approximately 36 percent on their electric bills compared to people living in homes built to current standards of construction. Perhaps equally important those investments provide homeowners and residential consumers with essentially inflation-proof investments. There are basically no fuel costs involved once you've made a conservation or solar investment. So once you've paid off the capital costs you're not paying for fuel. Our solar water heaters in Memphis cost $12 a month in terms of capital costs and we figure that will provide about 75 percent of the hot water needs to those families. That's $12 a month right now and it's $12 a month for the 25 years of the program. It won't increase any.

Unfortunately we're not able to make the same statement about fuel costs. I would be tempted to say, were it not in such bad form, that these investments are, therefore, too cheap to meter but I'll hesitate in doing that.

COST EFFECTIVE TO POWER SYSTEM

These investments are also very cost effective to the power system. Our calculations indicate that we are providing equivalent capacity something on the order of—the numbers are a little rough—somewhere between $150 and $400 a kW compared to other potential investments which are somewhat higher than that. Conservation investments are also generally ecologically benign although we are looking at some cases where there may be some minor problems such as wood heaters. Finally, they tend to be slightly more labor intensive than other forms of investment and that can't help but generate more jobs in the valley.

TVA LEADER IN CONSERVATION PROGRAMS

The second point I think it important to make is that because of the attractiveness of the programs, we have, in fact, incorporated them as an integral part of our power system. We have now the most comprehensive and aggressive conservation and renewable resource program in the Nation. Let me give you three indices of that. If you look at our load forecasts for 1990, you'll find that 7 to 10 percent of the electrical energy that we project to be consumed in the valley in that year will be provided by conservation and solar investments. Moreover, we find that 11 to 16 percent of the capacity that we'll need to meet our winter peak, or somewhere between 4,000 and 6,000 megawatts, will be provided by those same conservation and renewable programs.

IMPLEMENTING GAO RECOMMENDATIONS

The second index of our seriousness in this area concerns the GAO recommendations in the analysis area. Of the 11 recommendations which they made, we have either accomplished or are in the process of implementing 10 of those 11. The eleventh, the one which we have not implemented, in the one which relates to surcharges, on which I believe there was a dialog earlier. In two cases, in fact, we're going further than the GAO recommendations call for. They simply said, implement the national energy plan; our home insulation program goes further than that.

We have added three additional programs not recommended by the GAO in their report; the program for wood heaters, an aggressive commercial and industrial conservation program and a program where we are considering mandatory building standards.

The third measure by which I think we should be judged is our recognition that these programs have substantial costs; we project somewhere between $700 million and probably closer to $1.3 billion cumulatively by 1990. That's a significant amount of money and I think that it ought to be reasonably clear that we are serious about these programs if we propose to invest those sorts of sums in them.

In conclusion, let me say that this is truly an ambitious program. I know of no electric utility in the country that can come anywhere close to matching it and I think it's something we can all be proud of.

PREPARED STATEMENT OF ROBERT S. HEMPHILL, JR., DIRECTOR OF ENERGY CONSERVATION, TENNESSEE VALLEY AUTHORITY

Conservation and Renewable Resources Programs

As indicated in the report to the Congress prepared by the General Accounting Office, conservation and renewable resources are key components in solving the Nation's energy problems. TVA has recognized the role conservation should play and has placed increased emphasis on expanding its conservation efforts to the extent that we now have the most aggressive and comprehensive program in the Nation.

Our conservation efforts will play an important role in reducing energy consumption in the Valley area, thus reducing power supply costs and offsetting the need for costly generating facilities. However, these benefits are not received without associated costs. Present estimates indicate that up to $1 billion of capital could potentially be used to support an ambitious long-term conservation program.

TVA's conservation programs are expected to result in electricity savings in 1990 of 15 to 20 billion kWh. Admittedly, these projections are ambitious. Many factors such as consumer acceptance and participation, and unforeseen technical, institutional, and environmental problems could well affect the attainment of program goals.

We are presently studying various rate reform and load management programs. These programs have not been incorporated in our load forecasts and will most likely be required to attain the projected energy and capacity savings already attributed to our conservation efforts. They should also produce additional capacity and energy savings which we have not quantified.

TVA has several major programs which are well underway as well as others still in the planning phases. To provide better insight into the nature of our programs, brief summaries of various programs are provided.

Home Insulation Program

The TVA Home Insulation Program is designed to promote energy conservation and the more efficient utilization of electricity by encouraging all residential consumers to have adequate insulation and other weatherization measures. The program provides onsite energy surveys and recommendations for all interested residential consumers and subsidized financing to cover the cost of insulation and other weatherization measures in dwelling units that are either heated or cooled electrically.

Consumers who request a survey, whether they have electric heat or electric air-conditioning, are provided with complete recommendations on how they can have a more energy-efficient dwelling unit. The energy advisor will consult with the consumer to help find sources of funds that can be utilized for weatherization measures if the consumer is not eligible for a subsidized loan. There are many conservation measures recommended by the energy advisor that can be performed by the consumer himself, thereby providing him direct benefits from the survey and recommendations prepared by the energy advisor.

Through 1978, 87,726 surveys have been completed and 30,348 consumers have used the program to install weatherization materials.

The reduction in electric use by participants in this program will permit savings in capacity and fuel costs, thereby benefiting all consumers of TVA power through lower rates than would otherwise be required. TVA will seek to achieve an estimated reduction in peak demand of 1,099 megawatts after an 8-year period, which would result in lower capacity requirements and lower generation and purchased power cost for peaking. It is estimated that this program, which is more comprehensive than that required by the National Energy Act, can result in an annual energy reduction of 2.7 billion kWh after an 8-year period.

HEAT PUMP FINANCING PLAN

This program is designed to expand the Home Insulation Program by making available a loan for consumers who install a heat pump in an existing dwelling and meet certain installation requirements. Loans for heat pump installations would be repaid over a 10-year period and would include interest at 8.5 percent per annum. Based on an average loan of $2,000 for a heat pump retrofit installation, a total of $47.25 million will be outstanding in 1985. Total estimated operating cost over the program's 8-year life is $5.9 million.

Program goals call for 5,000 retrofit heat pump installations per year. Based on 4,270 kWh savings per year and 0.7 kW savings per heat pump installation, 1985 system savings are approximately 150 million kWh and 21 megawatts of capacity. Over the program's 8-year life, total savings equate to approximately $12 million.

SUPER SAVER HOME PROGRAM

A house built to Super Saver standards will yield an annual reduction in heating and cooling energy of approximately 50 percent compared to conventional construction. $uper $aver homes are currently being built in the Tennessee Valley area, but of the 60,000 new homes built in the past two years, only 1,000 were built to $uper $aver specifications.

It is apparent that the current low-key voluntary program should be expanded and emphasized to encourage many new homes to meet Super Saver type standards. Beginning February 27, 1979, TVA will hold public hearings on service practices. One practice to be considered is that new buildings, including homes, must meet energy conservation weatherization standards developed by TVA as a requirement for electric service.

Program goals call for approximately 140,000 Super Saver homes to be built in 1985. Based on 8,750 kWh savings per year and 1.64 kW savings per Super Saver home, 1985 system savings are approximately 1,203 million kWh.

COMMERCIAL AND INDUSTRIAL (C&I) CONSERVATION PROGRAM

Sixty-eight percent of all energy generated by TVA is consumed in the commercial and industrial sector. In 1977 this represented 80 billion kWh which were consumed by approximately 50 directly served TVA customers and 285,000 distributor-served customers.

TVA is implementing an in-depth audit program for commercial and industrial customers for all forms of energy and will include estimated economic payback periods for each recommended energy conservation opportunity (ECO). The audits will be free to all nonprofit C&I customers. Profit making customers will be charged for the audits and rebated $1 of the audit charge for every $2 invested in electrical ECO's. Our goal is 5,000 C&I audits per year when the program is fully operational. Private consultants will be utilized in addition to TVA's field engineers. We will also be working closely with architects and consulting engineers to improve the energy efficiency of new structures.

To help ensure the implementation of the ECO's identified in the audits, TVA will make available loans to the C&I customers. These loans will be available for a maximum of 10 years with a maximum of $100,000 per site and will bear an interest rate equal to TVA's current debt interest rate plus 1 percent. It is estimated that the maximum outstanding loan balance will be approximately $280 million which will occur in 1985.

Energy conservation forecasts for the year 1990 indicate savings of 6.3 billion kWh in energy usage and 1,120 MW in demand. We estimate the audit potential of the existing customers to be a maximum of 150,000. Of these audits, approximately 35,000–40,000 will be for nonprofit organizations, including educational facilities, hospitals, governmental buildings, churches, and clubs. Approximately 225 specific type conservation workshops will be presented during the first few years of the program.

SOLAR WATER HEATING PROGRAM

TVA has begun a demonstration program in Memphis to finance solar water heating systems with no downpayment and a 3.4 percent 20-year loan. Several of the 1,000 systems have already been installed. Each system is expected to pro-

vide 75 percent of the hot water for a typical 4-member family. The South Memphis Community Development Corporation, a nonprofit community development corporation, trained the workers who are installing the systems. Each system will save approximately $600 (present worth) in reduced energy and electric generating costs over the 20-year term of the loan. This savings is used to finance the loan program. A sample of the water heaters will be instrumented to evaluate their performance. If this program proves successful, we will consider expanding it throughout the Valley.

WOOD HEATING PROGRAM

TVA has begun a demonstration program to finance the installation of modern, efficient wood heaters with no downpayment, interest-subsidized 3- to 5-year loans. The first of 1,000 heaters is now being installed in North Georgia. Each homeowner who installs a heater is expected to save about $66 per year in electricity costs. A sample of the heater installations will be instrumented to determine efficiency and environmental impact. The heaters are expected to save TVA an estimated 6,112,000 kWh of electricity annually and 6 megawatts of peaking capacity. If the program proves successful, we will consider expanding it throughout the Valley. There may be some areas where the ambient air quality standards of the Clean Air Act will preclude such a program, however.

COGENERATION

TVA has recently completed a preliminary assessment of the potential for cogeneration in the TVA service area over the next 20 years. Work is in progress to achieve completion of a final draft and this assessment should be published during the first half of 1979.

A Cogeneration Task Force is working on program plans for the development of the cogeneration potential. Current options under consideration may include TVA technical and financial assistance and maintaining favorable standby power rates and other assistance where needed. Program efforts under this option are estimated to transfer loads that would otherwise be served from the TVA grid of about 285 MW and annual energy production of about 2.2 billion kWh to industry-owned inplant generation facilities by 1990.

If it is possible to develop more attractive methods of TVA financial assistance and with favorable economic conditions in industry, it may be possible to achieve a higher level of cogeneration development in the industrial plants and energy park complexes. With this more intense effort it may be possible to achieve the installation of about 625 MW in industrial plants and energy park complexes by 1990. These facilities could have an estimated annual energy production of about 4.6 million kWh for loads that would otherwise be served by TVA-owned facilities.

SUMMARY

The preceding summaries represent some of the programs which we have taken into account in developing our recent load forecasts. Our alternative load forecasts also include anticipated savings from other programs under development. Examples of such programs include: extended efforts in the home insulation and heat pump programs, Valley-wide solar space heating and water heating programs, residential biomass program, and commercial and industrial biomass program. Potential savings are provided on the attached table.

As indicated earlier, TVA hopes to achieve an electricity savings in 1990 of 15 to 20 billion kWh through successful implementation of these programs. Expressed in terms of capacity savings rather than energy savings, accomplishment of program goals would be equivalent to offsetting the addition of three or four large generating units.

The achievement of these projected energy and capacity savings requires a significant amount of capital. Of the $15 billion in borrowing authority we may want to use up to $1 billion in cost effective facilities that will be candidates for future investment to achieve an energy saving of up to 20 billion kWh. It is important that TVA be provided this additional borrowing authority in order to carry out its conservation objectives.

EXISTING AND POTENTIAL TVA CONSERVATION PROGRAMS

Program	Description	1990 energy savings (millions of kilowatt-hours)	1990 capacity savings (winter peak) (megawatt)	1979–85 estimated capital requirements (millions of dollars)[1]
RESIDENTIAL				
Home insulation program	Approximately 43,200 loans per year	3,100	1,412	187.8
Super saver home program	36,000 homes per year built to energy efficient super saver standards.	[2] 2,100	[2] 754	52.1
Residential heating equipment:				
Heat pumps:				
Low	Low-interest loans (8½ percent) provided; 5,000 per year from heat pump financing plan; approximately 15,000 per year through super saver efforts.	[3] 800	[3] 372	52.8
High	Low-interest loans provided; intensified effort; 19,000 per year from heat pump financing plan; approximately 36,000 per year through super saver efforts.	[3] 2,200	[3] 1,052	211.9
Biomass:				
Low	Expanded wood heater loan or incentive program; estimated 31,000 homes in 1990.	170	166	6.2
High	Expanded wood heater loan or incentive program; estimated 94,000 homes in 1990.	500	500	18.6
Solar active system:				
Retrofit:				
Low	Solar active heating systems developed as "add-on" packages for retrofit; 2,800 units in 1990.	20	18	9.0
High	More intensified effort; 28,400 units in 1990.	180	186	90.8
Solar water heating:				
Low	Expanded solar water heating program with loan or incentive plan; 53,000 units in 1990.	150	69	67.7
High	Intensified effort; 163,000 units in 1990.	500	211	208.4
Passive solar homes (new homes):				
Low	11,600 units in 1990	70	45	21.5
High	27,200 units in 1990	140	90	43.1
Electrified transportation	200,000 vehicles in 1990	−1,400	−209	14.0
Total, residential		5,000–7,300	2,625–3,995	410–825
COMMERCIAL AND INDUSTRIAL (C. & I.)				
Solar:				
Low	Encourage active and passive solar thermal systems for space and process heat; 10-percent penetration by 1990.	400	100	20.7
High	20-percent penetration by 1990	1,200	217	81.6
Biomass:				
Low	Encourage the use of industrial biomass systems for industrial space and process heating applications; 2-percent penetration by 1990.	400	79	41.2
High	3-percent penetration by 1990	600	118	61.1
C. & I. conservation program	Low-interest loans up to $100,000 to carry out ECO's.	6,300	1,120	281.0
Cogeneration:				
Low	Moderate financial assistance program; favorable standby power rates.	2,200	285	20.5
High	Intensified effort; more attractive financial assistance program.	4,600	625	34.0
Total, commercial and industrial.		9,500–12,700	1,585–2,080	365–460
Total, residential and commercial and industrial.		14,500–20,000	4,210–6,075	775–1,285

[1] These include existing programs that will be candidates for expansion and new programs that will be candidates for future investment. The actual investment made could vary somewhat from the estimated capital investment requirements shown here. As more experience is gained some shifts in capital requirements could occur to insure the most cost effective investments are funded.

[2] Energy and capacity savings represent insulation savings only.

[3] Energy and capacity savings for heat pumps installed in super saver program are included along with heat pumps installed through heat pump financing plan.

STATEMENT OF HUGH G. PARRIS, MANAGER OF POWER, TENNESSEE VALLEY AUTHORITY

Mr. PARRIS. Thank you, Senator Sasser.

I am pleased to be here today to explain how TVA is planning for the future electric power needs of the Tennessee Valley area, what we expect those needs to be, and what TVA is doing to meet them.

ENERGY CONSERVATION PROGRAM

To carry out its responsibilities for meeting the energy needs of the future, TVA needs the authority to borrow funds to provide for the electrical needs of a growing region as well as to support energy conservation efforts designed to keep electric bills as low as possible. As Mr. Hemphill has explained, we are very optimistic about the possibilities of energy conservation measures and new technologies, such as solar, for producing energy. TVA now has what I think is the largest—and the best—energy conservation program in the Nation—a program that will save the energy equivalent of three or four large generating units by 1990.

In our response to the General Accounting Office's report entitled "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority," it was pointed out that TVA has been actively engaged in the implementation and consideration of essentially all of the report's suggested conservation innovations for some time now. In fact, the report in many ways simply mirrors current TVA programs.

And I'd like to offer a copy of our response to the GAO report for the record.[1]

Senator SASSER. It will be incorporated in the record.

TVA COMMITTED TO LOW POWER RATES

Mr. PARRIS. There is one area where GAO and TVA do differ, however. The GAO report recommended consideration of a surcharge that would raise TVA power rates purely for conservation purposes. We support conservation but we retain our traditional commitment to low power rates. While we will use rate design to support conservation activities, we will never raise rates solely to promote conservation.

INFLATION KEY TO POWER RATE INCREASES

Our goal is to hold power rate increases to no more than the rate of inflation. To accomplish this, it will be necessary to use existing generating facilities as efficiently as possible, encourage as much energy conservation as we possibly can, avoid commitments to facilities which we do not absolutely need, hold down increases in fuel prices to the extent that we can, and in every other way possible conduct our activities with a deep regard for what cost increases mean to the power consumer.

WHY INCREASED BORROWING AUTHORITY IS NEEDED

We can set high goals for conservation and for power system efficiency—and we have. But, we must also be realistic about future de-

[1] See p. 113.

mands for electrical energy. This does not mean that we lower our conservation or efficiency goals, but it does mean that we must have the authority to take appropriate action when it is needed to provide sufficient amounts of electric power for the region's needs. This is why TVA will be requesting Congress to increase TVA's authority to borrow by $15 billion. This amount is based upon a load forecast which has projected annual growth rates in electricity consumption of 4.6 percent between 1978 and 1990 and 3.8 percent from 1990 to the year 2000. It assumes a high level of economic growth as represented by employment within the TVA region, a moderate amount of substitution of electricity for natural gas, electricity prices increasing no faster than inflation, and TVA's implementing aggressive conservation programs in its service area.

Our current projections take into consideration three different levels of regional economic growth, three different sets of energy prices, three different levels of electricity substitution for natural gas and two different levels of effectiveness of our energy conservation programs. All together we have generated some 54 different projections from these fairly basic sets of assumptions. These are explained in some detail in a paper prepared by Mr. Maxwell which, with your permission, I'd also like to submit for the record.[1]

Senator SASSER. It will be incorporated into the record.

ECONOMIC GROWTH IN TVA AREA

Mr. PARRIS. Historically, the TVA area has experienced rapid economic growth when compared to the Nation. Prior to the 1975 recession, gross regional product in the TVA area grew approximately one and a half times as fast as gross national product. Likewise, total employment in the valley increased much faster than total employment in the United States. This has helped close the gap between incomes in the TVA area and in the Nation. In 1977 TVA area income per capita reached 80 percent of U.S. income per capita. We continue to believe that the region will experience high economic growth relative to the Nation during the coming decade. We can imagine a region growing at a lower rate, energy prices growing faster than the rate of inflation, perhaps some less substitution of electricity for fossil fuels, and lower conservation program effectiveness. Under these conditions, our capital requirements would be less. We can even postulate a situation where conditions are such that no new powerplants are required beyond replacement of some of our existing facilities as they reach an age where they can no longer be used economically. But this is not in consonance with what we understand to be TVA's responsibility to the Valley.

PROVIDING ENERGY REQUIREMENTS FOR REGIONAL ECONOMY

We believe our responsibility to the region requires that we provide for the energy requirements of a growing regional economy. This is the basis for our $15 billion estimate.

The increase would provide for the completion of plants already under construction, the funding of some $1 billion in conservation and

[1] See p. 120.

alternative energy investments, additional environmental protection facilities and plant improvements, and the continued development of fuel resources for both coal-fired and unclear generating units. It would also provide full funding for about 7,200 MW of additional generating capacity at an average cost of about $1,500 per kW. This would supplement existing plants either in operation or under construction as needed to meet energy requirements. The nature of these plants cannot be identified at this time, but they could be conventional coal-fired or nuclear generating stations, or they could be fluidized-bed combustion plants, cogeneration facilities, fuel cells, or solar or other alternative sources. The actual type of plant will, of course, be determined later in the planning period as our knowledge of needs and the costs of various options becomes more specific.

The type of generation is not the issue. What is at issue is the ability to add capacity as it is needed. Approximately 10 to 12 years is presently needed to plan and build power supply facilities. This long lead-time requires that TVA be ready now to make commitments for power needs in the 1990's.

FINANCIAL CAPACITY TO MEET GROWTH NEEDS

A $15 billion increase in borrowing authority would provide the authority to make the commitments required in the next 5 years to insure an adequate long range supply of electricity. Without this increase, TVA would not be able to meet the energy demands of sustained economic growth in the region which it serves. Admittedly, there is some uncertainty about the exact rate of growth which will occur. Even so, we must have the financial capacity to meet what we consider to be a reasonably probable pattern of growth. In other words, we must plan for what is likely to happen. This is not to say that we will make commitments in the same manner. Future capacity will be committed to only when we are confident that it is needed. Simply put, we propose to commit against the $15 billion only as it is needed.

It is possible to calculate our additional requirements for borrowing authority under almost any load growth assumptions. Some additional capacity would be required under most of our forecasts. For example, we estimate that 3,000–4,000 MW of additional capacity would be required before the turn of the century under load growth conditions similar to the low GAO forecast when proper consideration is given to transmission and hop losses, interdivisional TVA loads, and other factors not discussed in the GAO report.

But the basic point is that we are not planning on any single forecast. We are looking at the range of alternatives. From this analysis we derive a reasonable basis for proceeding with planning for additional generating facilities subject to changes in the plan as economic and other conditions develop. This becomes the basis for the $15 billion requested increase in borrowing authority.

$15 BILLION INCREASE ADEQUATE TO FINANCE COMMITMENTS

The legislative history of TVA's requests has been one of seeking adequate borrowing authority to fully finance commitments contemplated in the following 5 years for the power program. The re-

quest for a $15 billion increase in borrowing authority would be adequate to fully finance commitments made through fiscal year 1985. These commitments would include all of the generating facilities contemplated for 1995 which, because of the 10- to 12-year leadtime, would require action during the coming 5 years.

Let me emphasize that we have financial obligations that must be met even if we build no additional plants. These involve the completion of plants currently under construction, improvements and additions needed in existing plants, and the funding of conservation and demonstration programs. Even under the assumption of no new plant starts, we must have additional borrowing authority.

Exhibit 1 to my testimony [1] summarizes our existing program and shows how the current construction program might be augmented with additional generating facilities designed to meet the region's energy requirements through 1995 under the forecast described above. Under this projection, commitments of approximately 7,200 megawatts of additional generating capacity would be needed by 1985.

Exhibit 2 [2] presents TVA's estimate position with respect to power funds and borrowing authority at the end of each fiscal year through fiscal year 1985. As indicated on this exhibit, an increase in the present $15 billion borrowing authority is needed to complete the plants we now have under construction. By 1985 about $30 billion of borrowing authority will be required to fully finance the power program, including those capacity additions which must be committed by the end of fiscal year 1985.

INCREASED BORROWING AUTHORITY PROVIDES FLEXIBILITY

The second thing that I would like to emphasize is that the increase in borrowing authority is not in itself a commitment to investment in new energy facilities. It provides us with the authority to proceed when it is necessary to do so. Such decisions will be made only when it becomes apparent that our existing programs and facilities are not adequate to meet future electricity requirements.

The $15 billion increase in the borrowing authority provides TVA the ability to meet the region's electrical needs that would result from continued regional growth, aggressive conservation programs, and electricity rates which increase no faster than inflation. The $15 billion would permit TVA to fully finance the generating facilities obligated by 1985 as well as the cost of carrying out its conservation programs. However, it does not provide for contingencies which may be needed for retirements, cost increases in our present construction program, or additional environmental protection facilities which may be needed in the future.

It would be nice if we could hold up our actions until we see what the future is really like. We cannot. We believe that an additional $15 billion of borrowing authority is needed for us to adequately discharge our responsibility to the region. What we ask is your support in providing us with the authority to deal with the region's energy needs.

[1] See p. 67.
[2] See p. 68.

Thank you.

Senator SASSER. Thank you, Mr. Parris.

PREPARED STATEMENT OF HUGH G. PARRIS, MANAGER OF POWER, TENNESSEE VALLEY AUTHORITY

FUTURE POWER NEEDS

I am pleased to be here today to explain how TVA is planning for the future electric power needs of the Tennessee Valley area, what we expect those needs to be, and what TVA is doing to meet them.

CONSERVATION PROGRAM BEST IN NATION

To carry out its responsibility for meeting the energy needs of the future, TVA needs the authority to borrow funds to provide for the electrical needs of a growing region as well as to support energy conservation efforts designed to keep electric bills as low as possible. As Mr. Hemphill has explained, we are very optimistic about the possibilities of energy conservation measures and new technologies, such as solar, for producing energy. TVA now has what I think is the largest—and the best—energy conservation program in the Nation—a program that will save the energy equivalent of three or four large generating units by 1990.

In our response to the General Accounting Office report entitled "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority," it was pointed out that TVA has been actively engaged in the implementation and consideration of essentially all of the report's suggested conservation innovations for some time now. In fact, the report in many ways simply mirrors current TVA programs.

TVA COMMITTED TO LOW POWER RATES

There is one area where GAO and TVA do differ. The GAO report recommended consideration of a surcharge which would raise TVA power rates purely for conservation purposes. We support conservation but we retain our traditional commitment to low power rates. While we will use rate design to support conservation activities, we will never raise rates solely to promote energy conservation.

Our goal is to hold power rate increases to no more than the rate of inflation. To accomplish this, it will be necessary to use existing generating facilities as efficiently as possible, encourage as much energy conservation as we possibly can, and avoid commitments to facilities which we do not absolutely need, and hold down the increases in fuel prices to the extent that we can, and in every other way possible conduct our activities with a deep regard for what cost increases mean to the power consumer.

We can set high goals for conservation and for power system efficiency—and we have. But, we must also be realistic about future demands for electrical energy. This does not mean that we lower our conservation or efficiency goals but it does mean that we must have the authority to take appropriate action when it is needed to provide sufficient amounts of electric power for the region's needs. This is why TVA will be requesting Congress to increase TVA's authority to borrow by $15 billion. This amount is based upon a forecast which has projected annual growth rates in electricity consumption of 4.6 percent between 1978 and 1990 and 3.8 percent from 1990 to the year 2000. It assumes a high level of economic growth as represented by employment within the TVA region, a moderate amount of substitution of electricity for natural gas, electricity prices increasing no faster than inflation, and TVA's implementing aggressive conservation programs in its service area.

Our current forecasts take into consideration three different levels of regional economic growth, three different sets of energy prices, three different levels of electricity substitution for natural gas, and two different levels of effectiveness for our energy conservation programs. All together we have generated some 54 different forecasts from these fairly basic sets of assumptions. These are explained in some detail in a paper prepared by Mr. Maxwell which, with your permission, I would like to submit for the record.

ECONOMIC GROWTH IN TVA AREA

Historically, the TVA area has experienced rapid economic growth compared to the Nation. Prior to the 1979 recession, gross regional product in the TVA area grew approximately one and a half times as fast as gross national product. Likewise total employment in the Valley increased much faster than total employment in the U.S. This has helped close the gap between incomes in the TVA area and in the Nation. In 1977 TVA area income per capita reached 80 percent of U.S. income per capita. We continue to believe that the region will experience high economic growth relative to the Nation during the coming decades. We can imagine a region growing at a lower rate, energy prices growing faster than the rate of inflation, perhaps some less substitution of electricity for fossil fuels, and lower conservation program effectiveness. Under these conditions, our capital requirements would be less. We can even postulate a situation where conditions are such that no new power plants are required beyond replacement of some of our existing facilities as they reach an age where they can no longer be used economically. But this is not in consonance with what we understand to be TVA's responsibility to the Valley.

We believe our responsibility to the region requires that we provide for the energy requirements of a growing regional economy. This is the basis for the $15 billion estimate.

BENEFITS TO BE DERIVED FROM $15 BILLION INCREASE

The increase would provide for the completion of plants already under construction, the funding of over $1 billion in conservation and alternative energy investments, additional environmental protection facilities and plant improvements, and the continued development of fuel resources for both coal-fired and nuclear generating units. It would also provide full funding for about 7,200 MW of additional generating capacity at an average cost of about $1,500 per kW. This would supplement existing plants either in operation or under construction as needed to meet energy requirements. The nature of these plants cannot be identified at this time, but they would be conventional coal-fired or nuclear generating stations or they could be fluidized-bed combustion plants, cogeneration facilities, fuel cells, or solar or other alternative sources. The actual type of plant will, of course, be determined later in the planning period as our knowledge of needs and the costs of various options becomes more specific.

The type of generation is not the issue. What is at issue is the ability to add capacity at the time it is needed. Approximately 10 to 12 years is presently needed to plan and build power supply facilities. This long lead time requires that TVA be ready now to make commitments for power needs in the 1990's.

A $15 billion increase in borrowing authority would provide the authority to make the commitments required in the next 5 years to ensure an adequate long-range supply of electricity. Without this increase, TVA would not be able to meet the energy demands of sustained economic growth in the region which it serves. Admittedly, there is some uncertainty about the exact rate of growth which will occur. Even so, we must have the financial capacity to meet what we consider to be a reasonably probable pattern of growth. In other words, we must plan for what is likely to happen. This is not to say that we will make commitments in the same manner. Future capacity will be committed to only when we are confident that it is needed. Simply put, we propose to commit against the $15 billion only as it is needed.

It is possible to calculate our additional requirements for borrowing authority under almost any load growth assumptions. Some additional capacity would be required under most of our forecasts. For example, we estimate that 3,000–4,000 MW of additional capacity would be required before the turn of the century under load growth conditions similar to the low GAO forecast when proper consideration is given to transmission and shop losses, interdivisional TVA loads, and other factors not discussed in the GAO report.

PLANNING NOT LIMITED TO SINGLE FORECAST

But the basic point is that we are not planning on any single forecast. We are looking at the range of alternatives. From this analysis we derive a reasonable basis for proceeding with planning for additional generating facilities subject to changes in the plan as economic and other conditions develop. This becomes the basis for the $15 billion requested increase in borrowing authority.

The legislative history of TVA's requests has been one of seeking adequate borrowing authority to fully finance commitments contemplated in the following five years for the power program. The request for a $15 billion increase in bor-

rowing authority would be adequate to fully finance commitments made through fiscal year 1985. These commitments would include all of the generating facilities contemplated for 1995 which, because of the 10- to 12-year lead time, would require action during the coming five years.

Let me emphasize that we have financial obligations that must be met even if we build no additional plants. These involve the completion of plants currently under construction, improvements and additions needed in existing plants, and the funding of conservation and demonstration programs. Even under the assumption of no new plant starts, we must have additional borrowing authority.

TVA SCHEDULE TO MEET ENERGY REQUIREMENTS

Exhibit 1 summarizes our existing construction program and shows how the current construction program might be augmented with additional generating facilities designed to meet the region's energy requirements through 1995 under the forecast described above. Under this projection, commitments of approximately 7,200 megawatts of additional generating capacity would be needed by 1985.

The energy provided by these plants could be supplied by a variety of power supply technologies, including cogeneration, fuel cells, or fluidized-bed combustion plants, where these options prove to be economical. The type of capacity would be determined late in the planning process. No retirement of existing facilities was considered in determining the need for new facilities even though 40 of TVA's 63 coal-fired units will have been in operation in excess of 40 years by 1995. In addition, no contingencies have been included for additional environmental protection facilities beyond what is presently required.

POWER FUNDS AND BORROWING AUTHORITY

Exhibit 2 presents TVA's estimated position with respect to power funds and borrowing authority at the end of each fiscal year through fiscal year 1985. As indicated on this exhibit, an increase in the present $15 billion borrowing authority is needed to complete the plants we now have under construction. By 1985 about $30 billion of borrowing authority will be required to fully finance the power program, including those capacity additions which must be committed to by the end of fiscal year 1985.

The second thing that I would like to emphasize is that the increase in borrowing authority is not in itself a commitment to investment in new energy facilities. It provides us with the authority to proceed when it is necessary to do so. Such decisions will be made only when it becomes apparent that our existing programs and facilities are not adequate to meet future electricity requirements.

The $15 billion increase in borrowing authority provides TVA the ability to meet the region's electrical needs that would result from continued regional growth, aggressive conservation programs, and electricity rates which increase no faster than inflation. The $15 billion would permit TVA to fully finance the generating facilities obligated by 1985 as well as the cost of carrying out its conservation programs. However, it does not provide for contingencies which may be needed for retirements, cost increases in our present construction program, or additional environmental protection facilities which may be needed in the future.

It would be nice if we could hold up our actions until we see what the future is really like. We cannot. We believe that an additional $15 billion of borrowing authority is needed for us to adequately discharge our responsibility to the region. What we ask is your support in providing us with the authority to deal with the region's energy needs.

EXHIBIT 1

SCHEDULE AND COST OF FUTURE CAPACITY ADDITIONS ON TVA SYSTEM

Plant	Commercial operation date	Total cost ($10)	Size (MW)	Dollars per kilowatt
Sequoyah	October 1979, June 1980	1,300	2,441	533
Watts Bar	June 1980, March 1981	1,270	2,540	500
Bellefonte	September 1981, June 1982	1,625	2,664	610
Hartsville	June 1983, June 1984, December 1983, December 1984.	3,500	5,148	680
Phipps Bend	August 1984, August 1985	1,800	2,574	699
Yellow Creek	May 1985, May 1986	2,400	2,750	873
Investments in future power facilities committed by 1985.		11,250	7,200	1,560

EXHIBIT 2

OBLIGATIONS, BORROWING AUTHORITY, AND BORROWINGS THROUGH 1985

[In millions of dollars]

	1978	1979	1980	1981	1982	1983	1984	1985
Outstanding obligations	9,356	11,987	14,472	16,600	18,200	19,200	20,200	20,800
Cost to complete plants through Yellow Creek	6,392	4,986	3,733	2,500	1,500	700	200	100
Cost to complete plants after Yellow Creek				3,500	3,200	2,900	7,200	9,700
Required borrowing authority	15,748	16,973	18,205	22,600	22,900	22,800	27,600	30,600
Outstanding borrowings	7,195	9,300	11,100	12,850	14,100	15,800	17,300	18,100

Senator SASSER. Let me ask you a question about your charts there. On exhibit 2 you've got "Cost to complete plants after Yellow Creek." When is Yellow Creek scheduled for completion?

Mr. PARRIS. In 1986, sir.

INCREASING COSTS OF CONSTRUCTION PROJECTS

Senator SASSER. All right. Why is your figure going up there, 1984, 1985—why is your figure going up there from 2.9 to 7.2 and then—I believe that's 9.7 in 1985.

Mr. PARRIS. Is the line that you're referring to the cost to complete plants through Yellow Creek or beyond Yellow Creek?

Senator SASSER. I'm looking at the "Cost to complete plants after Yellow Creek," is the way you have it——

Mr. PARRIS. That represents the commitments for the 7,200 megawatts of additional capacity in the timeframe that I mentioned in my testimony. And because of the lead time for new capacity to which TVA would be having to commit additional facilities as we move through time. That's the reason that those numbers are increasing.

Senator SASSER. Thank you, Mr. Parris.

Mr. PARRIS. Thank you.

Mr. FREEMAN. I believe that completes our prepared testimony, Senator.

EFFECT OF SMALLER INCREASES IN BORROWING AUTHORITY

Senator SASSER. All right. I've got a few questions, Mr. Freeman, that I think it might be appropriate to ask. Just to sort of review the history of TVA's borrowing over the years, in 1959 TVA, when it first began to raise capital through the Federal Treasury, the debt ceiling was placed at $750 million. In 1966 it was raised to $1.75 billion. In 1970, the ceiling was raised again to $5 billion. And then in 1976, according to our figures it was increased by $10 billion, to a total debt ceiling of $15 billion. Now, there was considerable discussion at that time on the Senate Budget Committee with regard to increasing the debt ceiling $10 billion, and assurances were given at that time that this $10 billion increase would be adequate for at least the next 6 years, but here we are 3 or 4 years later coming back for an additional $15 billion increase on top of the original $10 billion increase. I'm going to be asked these questions by my colleagues on the Budget Committee.

Now the proposal has been made and been advanced, that the debt ceiling of TVA be increased, if it is to be increased, by smaller incre-

ments as the funds are actually needed rather than the $15 billion which is being proposed. Now how do you react to that?

Mr. FREEMAN. Well, I think that would be a very bad mistake in terms of enabling us to keep the lights on in the Tennessee Valley. As I tried to explain in my testimony, the impact of inflation has just been devastating. The $15 billion that we are seeking has the purchasing power of $10 billion in 1975 dollars. This is the same as the last time we came up, and has the purchasing power of $7 billion in 1970 dollars. The borrowing authority we are seeking for now represents our best judgment, considering inflation, of the full funding required to meet the additions to our power supply we would have to order, over the next 5-year period, for delivery through 1995. In 1975 and 1976, not only the TVA Board, but a lot of other institutions in this country, grossly underestimated the impact of inflation. Other factors too have affected the increased cost of our powerplants. There has been slippage in the timetables, as you know, and because of those slippages the building of those plants has taken more person-hours than we had estimated.

IMPACT OF NRC SAFETY REQUIREMENTS

Another fact is that the Nuclear Regulatory Commission has imposed additional safety requirements. I'm not quarreling with those requirements—we want those plants to be as safe as we know how to make them—but the requirements have caused plants to be retrofitted. We had not counted on tearing materials out and building them back. I think it's good that we did make the safety improvements, but it has cost more money.

INTEREST RATES INCREASE COST OF PLANTS

We had not contemplated that the interest rates would go up the way they have. They are very capital-intensive facilities so interest costs during construction add substantially to the project cost. Higher interest rates mean large increases in the costs of plants.

The bottom line, however, is that the Tennessee Valley Authority is building these nuclear plants at about 25 percent less per kW hour than utilities in our part of the country and at costs less than the average throughout the Nation. We want to do an even better job. Since I've been on the Board we have commissioned Theodore Barry and Associates to make an independent study of our construction program. That study has been completed and we are incorporating and implementing their recommendations. We intend to do better, and do the very best we know how. We have a record that I think will withstand scrutiny, but it must be scrutinized, as you suggest.

CONGRESSIONAL OVERSIGHT OF TVA

Senator SASSER. Well, the General Accounting Office suggested, I think, this morning that there be more congressional oversight over TVA and over TVA's activities, and one suggestion has been made that the $15 billion be gleaned through Federal appropriations, and this would give the Congress more oversight responsibility of TVA. What's your reaction to that?

Mr. FREEMAN. Well, my reaction is that we welcome oversight in the form of hearings like you're conducting today and we believe that our actions not only will withstand scrutiny but we hope that we will have a lot to tell the Congress about. But to go back to using the appropriations process to finance the TVA Power System would, I think, threaten our utility responsibility in a very fundamental way.

The budget cycle is a 2-year cycle. I don't know any way that we effectively can plan and make investments in a power system under a budget cycle which would require us to make decisions, firm decisions—we're not talking about borrowing authority, we're talking about firm decisions—2 years in advance of the time that we got the money. That would put us in a situation where each year there would be great uncertainty about how much money we would have to invest. It also would mean we would be competing for Federal funds with the rest of government. Those handicaps are inconsistent with carrying out a utility responsibility which must be met. The Congress and TVA struggled with this question back in the 1940's and 1950's. There was a grand debate and a great compromise. A wall was put around TVA; its service area was defined like any other organization with utility responsibility. We were taken off of appropriations and given the authority to borrow money outside the government. We feel that compromise has worked well for 20 years. While it may be nice to think about going back and getting appropriations and not having to pay 9½- and 10-percent interest for money, I believe the people of the Tennessee Valley are prepared to pay their own way. We're not asking for any subsidy from any other part of the country and we don't intend to subsidize them either. The statutory provisions with respect to TVA since the self-financing act have worked well, and, I would say, in a sense, "if it ain't broke, let's don't fix it."

EPA/TVA AGREEMENT ON COAL GENERATING FACILITIES STRATEGIES

Senator SASSER. You know what happened to the last man who said that, Mr. Freeman.

Let me just ask you one question here. In mid-December the TVA Board agreed to a settlement with the Environmental Protection Agency to bring its coal generating facilities into compliance with the EPA regulations. Now this proposed consent decree has been much discussed, and I might say cussed in some areas, and criticized by some as going too far and being too costly, and hailed by others as a great achievement. Now, the capital investment required to comply with this settlement will be raised through TVA's bonding authority, as I understand it. Now the General Accounting Office report deals at length with this proposed consent decree. The report outlines several different strategies TVA could utilize in complying with the Federal air pollution laws. I think there are basically three.

GAO APPROACHES TO AIR POLLUTION CONTROL

First, GAO outlines what it terms the "least cost strategy." Now that strategy calls for the choice of double alkali scrubbers for 12 of TVA's coal-fired generating units. The total capital cost of this strategy is $171 million, with an annual operating cost of $49 million.

Now the second strategy which the report outlines calls for a na-

tional demonstration of a wide variety of flue-gas desulfurization technologies, including some of which have yet to be proven. Now this strategy according to GAO, would have a total capital cost of $237 million and a total annual operating cost of $70 million.

Now, GAO's third strategy outlines what they consider a maximum environmental protection strategy and this would call for outfitting nine units with sodium sulfite scrubbers and three units with magnesium oxide scrubbers. And this maximum environmental protection strategy, according to the General Accounting Office, would have a capital cost of $257 million, and an annual operating cost of $117 million. Now clearly we're talking about a lot of money.

TVA/EPA METHOD MORE COSTLY THAN GAO'S

Now, Mr. Freeman, I've reviewed the proposed consent decree, and the Tennessee Valley Authority has agreed on compliance methods which have a total capital cost of more than $1 billion and an annual operating cost of $447 million. In other words, it appears to me that TVA has agreed on a method of compliance that appears to cost four times more than the maximum environmental protection strategy outlined by GAO. Now, by agreeing to this proposed settlement TVA itself, I'm told, has announced that wholesale rates will increase by 12 percent in the next 5 years. Now clearly, and I don't think anyone would argue, TVA should comply with the requirements of the Clean Air Act. TVA's got to obey the law like every other citizen. But the issue is whether TVA is proposing overcompliance and proposing a much more expensive method than is necessary and I'd like to get your comments on that.

TVA/EPA METHOD CHEAPER THAN GAO'S

Mr. FREEMAN. My reply is that we have agreed to the method of compliance which is the least cost method of compliance, not just in my opinion, but in the opinion of the people on our staff in the power organization who have struggled with this problem for a very good percentage of their professional lives. I don't have a photographic mind, but my recollection of the GAO report is that they were discussing only a portion of the cleanup campaign that we were forced to undertake. If you will give us the privilege of supplying, for the record, a comparable cost analysis, I think we'll be able to show you that our method of compliance is, in fact, the least cost, and less costly, than any of the options the GAO suggested. They're talking about a number of experimental scrubber-type technologies that are not commercially feasible yet. Using the technology GAO proposes would not enable us to comply in the decade of the 1980's when we already are years out of compliance. Also, they appear to be suggesting some compliance strategy, from what you have just said, that seems to me to be much more expensive than what we agreed to. Also, it does not take into account the concessions we got from EPA in our negotiations. If you would permit us the privilege of giving you a detailed comparable analysis, I believe we can document my comments.

Senator SASSER. We'll certainly leave the record open for that, Mr. Freeman, because it's a matter of some concern, considerable concern, when we see that TVA is going forward with, what on the surface appears to be, a method of complying with EPA's requirements that is four times more expensive than what the General Accounting Office has said might be necessary.

GAO METHOD NARROW AND UNPROVEN

Mr. FREEMAN. Senator, the numbers in the GAO report, as I hear you, referred only to the cost of some scrubbers. Our program includes investments that we've had to make to clean up particulate matter and a number of other items. The record should not be left with the inference that the GAO numbers are comparable to the $1 billion number that TVA is using. And, even leaving these other large considerations aside, GAO is talking about scrubbers that are theoretical and, I think, in some cases more expensive. They do not have a compliance strategy laid out in their report that would comply with the law. They talked about our experimenting with different types of scrubbers. Indeed, I submit that they were talking about options that would be tremendously more expensive if you consider that reliable electric power is worth more than unreliable electric power, and I think that you will find that most of our customers expect reliable electric power.

Senator SASSER. Well, I think that when you have this sort of basic conflict between two reputable and respected agencies of government, we need to get it resolved and lay this controversy to rest.

Mr. FREEMAN. To my knowledge, the GAO has not commented on our settlement proposal as such, even though the settlement is a matter of public record. But we will supply a comparable analysis. Quite frankly, I did not read the GAO report as purporting to comment on our total settlement package but only suggesting, essentially, that we put a lot of scrubbers in.

[The information follows:]

AN ANALYSIS OF THE TVA SULFUR DIOXIDE COMPLIANCE COST FIGURES AND THE GAO REPORT

The cost estimates in the General Accounting Office report, "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority," are not comparable to TVA's estimates for two reasons. (1) The GAO figures cover only the cost of double alkali flue gas scrubbers for SO_2 compliance at four plants; TVAs cost is for both SO_2 and particulate control at 10 coal-fired generating plants. (2) In addition, GAO understates the cost of double alkali scrubbers which in any event are not now sufficiently developed for large-unit installation.

FALLACY OF COST COMPARISON

The basic fallacy of the cost comparison is that the GAO report discusses only the cost of scrubber installation and operation, not the entire air compliance program. Scrubbers are being installed on portions of only 4 plants whereas the TVA program covers 10 coal-fired generating plants, not just the 4 mentioned in the report. At six plants, SO_2 compliance will be achieved solely by switching to new supplies of low-sulfur coal. The increased cost of this fuel is not included in the GAO figure. In addition, our program covers particulate removal equipment (precipitators and baghouses) which also is not included in the GAO figure.

TVA's strategies at each plant were developed to keep compliance costs to a minimum. Scrubbers are only being installed where that is the least costly method of obtaining required emission reductions. Where scrubbers are being

installed, the least expensive scrubbing system was selected. At Cumberland the cost estimates are based on the least expensive system for that plant (limestone) although it is hoped that an innovative system will be installed there. The strategies are summarized in the attached Table A. These same strategies were summarized in table 6–2 of the GAO report. TVA has estimated the total capital cost of this program to be $1.02 billion and the total annual cost of the program to be $447 million (1982 dollars) as shown on the attached Tables B and C.

TVA ESTIMATE OF COST OF SCRUBBER OPERATION

Of necessity, GAO's cost estimates are generalized estimates that do not take account of site-specific or back-fit problems. TVA estimates were originally developed on a plant-by-plant basis and have now been supported by detailed engineering studies. In the case of the Widows Creek and Paradise scrubbers, the estimates have been supported by bids submitted by potential contractors. TVA's estimated capital and annual operating costs for the scrubber installations are as follows:

			Millions of 1982 dollars	
	Scrubber capacity—MW	Scrubber type	Capital cost	Annual cost [1]
Cumberland	600	Undecided—cost estimated based on limestone.	90	27
Johnsonville	[2] 600	Magnesium oxide	185	36
Paradise	[2] 1,408	Limestone	220	62
Widows Creek	575	do	54	20
Total	3,183	Total	549	145

[1] Annual costs include amortization of investment over the remaining life of plant. For the limestone scrubber installations, costs include sludge stabilization, and disposal. For magnesium oxide installation, costs include acid plant, regeneration plant, and credit for sale of recovered sulfuric acid.
[2] Does not include approximately 20 percent redundant scrubbing capacity to improve system reliability.

In addition, TVA has installed and is operating a limestone scrubber at its Widows Creek Steam Plant unit 8. This unit has a capacity of 550 MW. The capital cost of the scrubber was $54 million and the annual cost is $20 million. Even if it were technically feasible to install double alkali scrubbers on the scale envisioned by GAO, TVA estimates that the cost would be about 5 percent greater than the estimates shown above.

By comparison, table 6–5 of the GAO report indicates that double alkali scrubbers could be installed on 3,183 MW of capacity at a capital cost of $171 million and an annual operating cost, excluding waste disposal, of $47.8 million. If the cost of waste disposal is included, as it is in TVA's figure, the annual cost is $74.1 million. These estimates of FGD system costs are not directly comparable, however. In the case of the TVA estimates, the scrubber costs are site specific, reflecting particular engineering and layout features at the plants which can have a significant impact on cost. For example, at the Johnsonville Steam Plant, flue gas must be carried from the powerhouse roof through new ductwork to ground level where the scrubbers will be located, then exited through a new ground-based chimney. These features can add significantly to the cost. The estimates in the GAO report are, by necessity, generic estimates and are not based on specific site features. In general, such estimates are normally most applicable to new sources where the scrubbing facility is designed and located in an optimum manner while the overall plant structures are being designed and located.

Furthermore, TVA capital cost estimates are based on costs that are expected to accure while these facilities are being constructed, i.e., during the 1979–82 period. TVA's annual cost estimates are in 1982 dollars. Thus, several years of inflationary effects separate the TVA and GAO estimates.

Finally, the TVA estimates include a substantial cost for backup scrubber capacity at its Johnsonville and Paradise Steam Plants. At Johnsonville, a spare scrubber train with a capacity of 200 MW is being installed on each unit so that, in the event that one of the five remaining trains malfunctions, the scrubbing facility will still be able to accommodate all the flue gas.

The GAO report recommends that TAV follow a maximum demonstration and development path at the four plants at which scrubbers are being installed. In substance, TVA is doing exactly this at no extra cost to the ratepayer. In making

this recommendation GAO developed what it termed a least cost scrubber program dependent upon double alkali scrubbers. The GAO estimates drastically understate the cost of double alkali scrubbers. In any event we do not feel that they are sufficiently developed to allow large-scale installation at this time. Even if they were a developed system, the cost of the GAO least-cost approach would be greater than the cost estimates TVA has developed for its program.

TVA does not believe that double alkali scrubber technology is sufficiently proven to warrant installation on the scale (3,183 MW) included in the GAO analysis. While TVA is considering the installation of 600 MW of double alkali scrubbers at its Cumberland Steam Plant, we do not propose to make such a selection until additional test information is available, which we expect during the summer of 1979. This assessment of the feasibility of installing double alkali scrubbers appears to be consistent with the assessment of other power systems since double alkali scrubbers comprise only 3 percent of the total scrubber installation either operational, under construction, or planned, whereas lime/limestone scrubbers make up nearly 90 percent of the scrubber capacity.

SO_2 PROGRAM CONSTRAINED BY AIR QUALITY STANDARDS

TVA's sulfur dioxide control program is constrained by the requirement that compliance with state and Federal air quality standards be achieved as rapidly as possible. However, TVA has not sacrificed the research and development opportunities this massive control program offers. The flue gas desulfurization equipment TVA is installing will employ a variety of designs, including advanced technology systems, and will significantly advance scrubber development. At our Paradise and Widows Creek plants we will be installing limestone scrubbers which will provide TVA an opportunity to continue its research in methods of achieving greater removal efficiency from this type of equipment and also to develop solutions to the problem of long-term sludge disposal. On the Johnsonville plant we are installing an advanced magnesium oxide scrubbing system which will produce sulfuric acid, a useful byproduct, instead of sludge. At Cumberland we are hoping to be able to use an advanced scrubbing system, utilizing an entirely new technology; however, these plans will be dependent upon the approval of a suitable schedule by EPA and the other plaintiffs in the litigation.

We believe this mix of scrubber systems will provide all of the research and development benefits that the report recommends.

It is significant that what GAO actually recommended was:

In complying with the proposed consent decrees, TVA should follow the maximum demonstration and development of flue gas desulfurization technologies in its coal-fired units, as proposed in chapter 6. Such a program would cost more than simple compliance would require and would entail certain risk. We recommend, therefore, that TVA request an appropriation for this program for those costs over and above simple compliance.

TABLE A.—SULFUR DIOXIDE AND PARTICULATE COMPLIANCE METHODS AND SCHEDULES

Plant	Emission limitation	Compliance method	Date
Allen	4.0 lbs SO_2	Medium-sulfur coal	May 1, 1979
	0.10 lbs particulates	Modified precipitators	Sept. 1, 1978
Colbert	4.0 lbs SO_2	Medium-sulfur coal	Aug. 1, 1979
Cumberland	4.2 lbs SO_2	Coal washing plus partial[1] scrubbing (600 MW).	Dec. 31, 1982
	0.10 lbs particulates	New precipitators	May 1, 1982
Gallatin	5.0 lbs SO_2	Medium-sulfur coal	Nov. 1, 1978
	0.10 lbs particulates	New precipitators	June 15, 1979
Johnsonville	3.4 lbs SO_2	Partial magnesium oxide scrubbing (600 MW) and medium sulfur coal.	Dec. 1, 1982
Kingston	2.8 lbs SO_2	Medium-sulfur coal	July 1, 1979
Paradise	3.1 lbs SO_2	Coal washing plus scrubbing units 1 and 2 (1,400 MW).	Sept. 1, 1982
	0.11 lbs particulates	New precipitators on unit 3 plus scrubbing 1 and 2.	Do.
Shawnee	1.2 lbs SO_2	Low-sulfur coal	Oct. 1, 1981
	0.11 lbs particulates	Baghouses	Nov. 1, 1981
Watts Bar	4.0 lbs SO_2	Medium-sulfur coal	Dec. 1, 1978
	0.14 lbs particulates	Modified boiler	July 1, 1981
Widows Creek	1.2 lbs SO_2	Low sulfur coal (units 1–6) and limestone scrubbing (units 7 and 8).	Sept. 1, 1981
	0.12 lbs particulates	Scrubbihg (unit 7)	Do.

[1] To be modified if advanced design scrubbing utilized.

TABLE B.—SULFUR DIOXIDE AND PARTICULATE COMPLIANCE METHODS AND ESTIMATED COSTS UNDER PROPOSED SETTLEMENT

[In millions]

Plant	Annual cost of Compliance 1982 dollars	Capital investment
Sulfur dioxide:		
Allen: Medium-sulfur coal	$8	
Colbert: Medium-sulfur coal	12	
Cumberland: Coal washing and partial scrubbing	59	$160
Gallatin: Medium-sulfur coal	13	
Johnsonville: Partial scrubbing and medium-sulfur coal	46	185
Kingston: Medium-sulfur coal	33	
Paradise: Coal washing and partial scrubbing	94	350
Shawnee: Low-sulfur coal and baghouses	86	80
Watts Bar: Medium-sulfur coal	0	
Widows Creek: Partial scrubbing and medium-sulfur coal	67	[1] 54
Total, SO_2 only	418	829
Particulates: New precipitators at Cumberland, Paradise unit 3, and Gallatin	29	191
Total	447	1,020

[1] Not including existing unit 8 scrubber.

TABLE C.—BREAKDOWN OF SULFUR DIOXIDE COMPLIANCE COSTS AT PLANTS WITH MORE THAN 1 COMPLIANCE PROJECT

[In millions of dollars]

Plant	Annual Cost of compliance 1982 dollars	Capital investment
Cumberland:		
Coal washing	$32	$70
Scrubbing	27	90
Johnsonville:		
Medium-sulfur coal	10	
Scrubbing	36	185
Paradise:		
Coal washing	32	130
Scrubbing	62	220
Shawnee:		
Low-sulfur coal	73	
Baghouses	13	80
Widows Creek:		
Low-sulfur coal	27	
Scrubbing	40	[1] 54

[1] Not including existing unit 8 scrubber.

ECONOMIC IMPACT STATEMENT ORDERED ON AGREEMENT

Senator SASSER. Well, I want to point out that on January 30, Federal District Judge Tom Wiseman of the middle district of Tennessee, refused to rule on the proposed consent decree. Judge Wiseman ordered an economic impact statement on the cost of this agreement and its estimated impact on inflation. And if there's no objection, I'd like to insert Judge Wiseman's order in the record at this point.

[The order follows:]

IN THE UNITED STATES DISTRICT COURT FOR THE MIDDLE DISTRICT OF TENNESSEE, NASHVILLE DIVISION

No. 77-3390-NA-CV

TENNESSEE THORACTIC SOCIETY, ET AL., PLAINTIFFS

UNITED STATES OF AMERICA, INTERVENING PLAINTIFF

v.

AUBREY WAGNER, ET AL., DEFENDANTS

ORDER

The Court is in receipt of a proposed consent decree submitted by the parties in this case. Before acting on the consent decree, the Court is of the opinion that it is essential to have information regarding the economic impact of such a consent decree on the residents and consumers of electricity in the Tennessee Valley. It is therefore ORDERED that both parties prepare and submit to the Court an economic impact statement, including the estimated increased cost per month per residential user expected to result from the implementation of the consent decree, as well as the estimated impact on inflation, including increased cost to commercial and industrial users and any such cost expected to be passed on to consumers. The Court will reserve approval of the consent decree until the parties have submitted such economic impact statements.

United States District Judge.

ADMINISTRATION VIEW OF AGREEMENT

Senator SASSER. Mr. Freeman, I'm in receipt of a letter from the Honorable Barry Bosworth, who is Director of President Carter's Council on Wage and Price Stability. And on January 10, Barry Bosworth corresponded with Mr. E. G. Chaves of the Consolidated Aluminum Co.

[The letter follows:]

EXECUTIVE OFFICE OF THE PRESIDENT,
COUNCIL ON WAGE AND PRICE STABILITY,
Washington, D.C., January 10, 1979.

Mr. E. G. CHAVES,
Consolidated Aluminum Co.,
St. Louis, Mo.

DEAR MR. CHAVES: Thank you for your mailgram of December 13, calling our attention to the pending action of the TVA Board on the proposed settlement with EPA. Unfortunately, because of the large volume of correspondence which we are receiving each day, your mailgram did not come to my attention until after action had been taken by the TVA Board.

However, I did request last fall that the TVA Board review the proposed settlement in light of the fact that essentially the same environmental result could be achieved at a lower cost. The TVA Board has chosen to adopt the proposed settlement. As a result, this decision will impose an unnecessary cost burden on the residential and industrial users of electric power in the Tennessee Valley.

Sincerely,

BARRY P. BOSWORTH,
Director.

Senator SASSER. But in this letter, Mr. Bosworth states, and I quote, "I did request last fall that the TVA Board review the proposed settlement in light of the fact that essentially the same environmental result could be achieved at a lower cost." Still quoting, "The TVA Board has chosen to adopt the proposed settlement. As a result, this decision will impact an unnecessary cost burden on the residential and indus-

trial users of electric power in the Tennessee Valley area." Now that's what Barry Bosworth says. Now, Mr. Freeman, the President's Council that is charged with monitoring inflationary practices is saying in essence that TVA was told last fall that the proposed settlement is unnecessarily high and could be achieved at a lower cost. Now here again, why did we enter into this agreement between TVA and EPA on this proposal agreement in the face of this information?

ADMINISTRATION DOESN'T UNDERSTAND PROBLEM

Mr. FREEMAN. Mr. Bosworth is just badly mistaken, he's just as wrong as he can be. He doesn't have the foggiest idea of what he's talking about on this subject. I did receive a communication from him. He's quarreling with the law passed by the Congress of the United States and the law as declared by the Supreme Court of the United States with respect to TVA and as modified in the 1977 Clean Air Act. And he is suggesting that that law, perhaps, should be different. But the law has been settled in this case and there was nothing more to litigate.

Senator SASSER. Well, as I understand what Mr. Bosworth is saying in his letter, he is saying that TVA could have complied with the requirements of the law, with the requirements of EPA, at a much lower cost than you did and Mr. Bosworth's opinions appear to be bolstered by the statements made by GAO, which indicate according to them you're paying four times too much.

TVA/EPA SETTLEMENT COST NOT CHALLENGED

Mr. FREEMAN. Mr. Bosworth is mistaken and the GAO report, I respectfully suggest again, does not purport to comment on our settlement or suggest that our settlement is not at lowest cost. I was making suggestions about types of technology and simply added up costs for the number of theoretical scrubbers it was talking about. GAO didn't include an awful lot of other expenses that the settlement required. The position of Barry Bosworth dealt with the stringency with which the law should be enforced and that was not decided by the TVA. TVA took that question to the EPA, took it to the court of appeals, and took it to the Supreme Court, but certiorari was denied. When I came to TVA, Mr. Lynn Seeber, the General Manager, came to me and he said:

Dave, we don't have anything to fight about anymore. We've got to settle this matter so we'll know what to do and keep these powerplants running.

We laid out a settlement strategy that was concurred in by our Manager of Power and everyone else, and may I say, Senator, probably the most money I've saved for the consumers in the Tennessee Valley since I've been here is the result of the effort I put into negotiating that settlement agreement. That agreement will withstand scrutiny by anyone. We had two choices; to go on with the litigation and run the risk of litigation in which the State of Alabama and the State of Kentucky were suing us, as well as the EPA, and where we would run the risk of fines and timetables that would be more stringent and more costly, and would require more scrubbers. We negotiated. We took advantage of the amendments that you and Senator Baker got with respect to the Kingston plant and the Johnsonville plant, advantages that we probably wouldn't have gotten in litigation. Our judgment is that we got a

good settlement. Senator, you're a lawyer and you know that in litigation the lawyers and the clients have to make judgments. There were no issues left to litigate. The standards were set by law. The only issues were the methods and the timetable.

TVA/EPA AGREEMENT BAD SETTLEMENT

Senator SASSER. Well, you see, here's the problem. Here's why I have problems following you entirely on that, Mr. Freeman. Now the General Accounting Office in its report, pages 6–18, outlines three strategies for clean air compliance by TVA, at least cost, maximum environmental protection and then the third one is a demonstration and they say you can comply with one-fourth of the cost. I mean, there are such things in the practice of law as bad settlements and I've seen lawyers make bad settlements. I might have made one or two myself. And what we're questioning here is whether or not TVA has made a bad settlement with the Environmental Protection Agency.

Mr. FREEMAN. I respectfully suggest that the GAO report does not provide any evidence on that issue one way or the other. It doesn't talk about the washing plants, the precipitators, and other equipment that are included in the $1 billion figure. The $1 billion figure is just not comparable with the GAO numbers, Senator. And I don't recall anything in the GAO report that spoke to our settlement agreement or purported to make that comparison. So that I think that we just simply have an orange there that you're trying to compare with an apple.

Senator SASSER. Well, the General Accounting Office does not refer specifically to your settlement agreement. But what it does refer to are three strategies by which you can comply with requirements of the Environmental Protection Agency and all of them are dramatically cheaper than the consent decree or the agreement TVA entered into.

GAO STRATEGIES DON'T COVER ALL COSTS

Mr. FREEMAN. I respectfully differ, Senator. They are not dramatically cheaper; they do not cover most of the items of expense that are included in our $1 billion figure.

Senator SASSER. Well, Mr. Freeman, we're going to pursue this further, and we look forward to getting data from you which we can incorporate in the record which will support TVA's position on this consent decree matter. As I understand it, Judge Wiseman's left the record open for additional comment on it before adopting a consent decree. Is that correct?

Mr. FREEMAN. Yes, sir, that's correct. The record is open, this is a procedure that is customary in settlements such as this to give the public a chance to comment and those comments can be filed with the Department of Justice, which will file them with the court.

RATEPAYER COSTS OF TVA PROGRAMS

Senator SASSER. Moving on to something else. The TVA's testimony is concentrated on additional power supply needs to support an increase in the bonding authority. Now there are two other major costs facing TVA in the next decade; one we've just discussed, is the imple-

mentation of the consent decree with the Environmental Protection Agency. The other involves TVA's interest in building their own "away from reactor" storage facility for spent fuel from a nuclear reactor. Now my question is, what means of funding does TVA intend to utilize in implementing both of these programs, that is, your consent decree and building your "away from reactor" storage facilities for spent nuclear fuel?

Mr. FREEMAN. Compliance both with the Clean Air Act and the Nuclear Regulatory Commission's requirements on a nuclear site are necessary costs of our power program. Funding for both programs you cite would be power expenses. To the extent that they represent capital items, they are reasons why we need the borrowing authority. To the extent that they represent expenses, they are power system costs that would be borne by the ratepayers.

COST OF DISPOSITION OF SPENT NUCLEAR FUEL

Senator SASSER. So ultimately, the ratepayers pay for the consent decree that you've entered into with EPA and ultimately the ratepayers, as you say, pay for the "away from reactor" storage of this spent fuel. This burden ultimately falls on the ratepayer?

Mr. FREEMAN. Let me make clear, Senator, that the TVA Board has not decided on an "away from reactor" facility for the spent fuel. We have before us the basic issue of whether the spent fuel will be stored at the reactor site or whether we will build "away from reactor" facilities. The spent fuel is a reality as we generate nuclear power and we are facing up to this heavy responsibility. TVA will be making a decision in broad daylight to decide which option to pursue. That will come up for decision, we hope, this summer. But we have not decided to build an "away from reactor" storage facility; we have decided to face up to our responsibilities to have public participation in that decisionmaking process and to make a decision.

Senator SASSER. Well, paying for the consent decree, cleaning up your coal-fired plants, and if you decide to pursue the "away from reactor" storage concept, I assume both of these would be paid for out of the $15 billion ceiling that you're seeking to have lifted.

Mr. FREEMAN. If I may, I would prefer to say that we are meeting the necessary expenses to comply with the Clean Air Act and the Atomic Energy Act, which are necessary expenses of producing coal-fired and nuclear-fired power. The——

COMPLIANCE WITH EPA STANDARDS AT LOWEST POSSIBLE COST

Senator SASSER. Well, I want to make it clear, Mr. Freeman, that I'm not quarreling at all with your willingness to comply with the EPA standards. That's the law of the land and they should be complied with. I'm only questioning whether or not we're in a posture of overcompliance and if we are in a posture of overcompliance then the ratepayers in the Tennessee Valley area are going to have to pay for that overcompliance. I'm eager to see that we comply with EPA standards, that TVA does, but I'm also equally eager to see that TVA comply with them at absolutely the lowest possible cost.

Mr. FREEMAN. Senator, no one is more eager to do that than I am. I respectfully suggest that we have done a very good job of getting

out of the almost decade-long turmoil of getting in compliance with the Clean Air Act at the lowest cost to the TVA ratepayer. This is not just my opinion but is in the judgment of our Manager of Power, our General Counsel and every other TVA staff official who struggled with this issue over this long period of time. Indeed, after counseling with the executive committee of our distributors, they were persuaded that our judgment was a sound one.

ELECTRONIC CONTROL OF ENERGY-USING APPLIANCES

Senator SASSER. Now water heaters account for almost 24 percent of the power used among TVA's residential customers. Now the GAO report analyzes several load management alternatives including time-of-day pricing and controlling water heaters by radio or by microwave. A similar suggestion has been made with regard to air-conditioners. Now I'm aware that the TVA is exploring these areas for possible application in the region. I think they have been applied, not in this country but perhaps in other countries. Now how would such a system for hot water heaters and air-conditioners work?

Mr. FREEMAN. If I may, Mr. Hemphill here, who is the expert on this subject, would be glad to explain that to you.

Mr. HEMPHILL. Senator, we are now conducting an experiment with four distributors, putting in about 400 water heaters, 50 air-conditioners and 50 heat pumps, which will cycle on and off by remote control. That experiment will work by what's called two-way radio control. That is, during times of peak load, which is when we need the extra capacity the most, we'll cycle those machines on and off by radio signals to small receivers which are located in the homes in the machines themselves. We'll probably cycle the air-conditioners on and off every 7 minutes so that they're never cut off for a very long period of time. They still would maintain about the same degree of coolness in the house, but we would save roughly half the power requirement. The water heaters we'll cycle on and off for differing lengths of time depending upon the storage capacity of each water heater. If you have a 120-gallon water heater you may be able to cycle it off for as long as 6 hours; if it's a 40-gallon water heater, you probably don't want to go much more than 45 minutes or an hour. One of the things we're not sure about is precisely what period of time you can cycle these things on and off and not seriously interfere with the normal process of a residential consumer, of washing clothes, cooking, and things of that nature. And that's one of the things we have to find out. We're not precisely sure about that.

PROGRAM TO BE VOLUNTARY

Senator SASSER. Well, it occurs to me that some homeowners might resent such control of their appliances by a utility. How are you going to cope with that?

Mr. HEMPHILL. The program which we are engaged in is an experiment. Participation in the program is entirely voluntary and there's a hold harmless provision in terms of rate impacts for the consumers. One of the things we want to test is, how, in fact, behaviorally, do people react to this in a behavioral sense. There are certain overtones that you correctly identified. Obviously, if we get substantial negative

reaction it would not be a program which we would recommend implementing any further.

Mr. FREEMAN. Could I comment on that, Senator? I share your concern about the "big brother" overtones of these load management devices and as far as the TVA board is concerned, we are not considering any program of that kind unless it is completely voluntary. But we do think there are such cost-saving opportunities involved that the use of the devices needs to be explored. Consumers may voluntarily want to have their power interrupted at certain times in exchange for a discount that may very well turn out to be attractive, but I would not dream of imposing such a system on anyone unilaterally.

INFLATION'S IMPACT ON BORROWING AUTHORITY

Senator SASSER. Mr. Freeman, we were talking earlier about inflation. What is TVA's projection for inflation between now and 1986, and how are you taking this into account in your planning?

Mr. FREEMAN. I believe Mr. Maxwell and Mr. Cross made detailed studies of our projections. Perhaps they ought to give you the precise number they used.

Mr. CROSS. We're projecting capital cost increases in these studies of approximately 8 percent per year.

Senator SASSER. And this is through 1986?

Mr. CROSS. Yes; it extends through 1986.

Senator SASSER. Now what amount of the $15 billion additional borrowing authority can be attributed to inflation? In other words, what are you asking for as far as a real increase in borrowing authority—what are you requesting as far as real increase in current dollars is concerned? Is there inflation figured in the $15 billion request?

Mr. FREEMAN. Yes; inflation is figured in it. Your question is, if we were able to freeze the value of the dollar today, how much money would we be needing?

Senator SASSER. That's right.

Mr. FREEMAN. Do you have that number?

Mr. CROSS. We don't have that number but it relates very closely to Mr. Freeman's earlier testimony, as far as inflation effects, that the $15 billion that we are requesting today, in terms of today's dollar, is significantly less than it would have been in 1976.

Mr. FREEMAN. The number is roughly around $10 billion; one-third of it is due to inflation.

Senator SASSER. Well, Mr. Freeman, I want to express my appreciation to you and your colleagues for appearing here today. We have additional questions which we would like to submit for the record and would request that you make your usual prompt and speedy response to.[1] I'd like to express my appreciation also, to Director Richard Freeman for his appearance here today. I understand he's convalescing from a recent operation and he looks hale and hardy. But thank you for being here.

Mr. FREEMAN. Thank you, Senator. Glad to have a chance to appear before you.

Senator SASSER. Our next witness is Mr. George Usry, representing the Tennessee Valley Public Power Association. Mr. Usry is the chair-

[1] See p. 105.

man of the Committee on Power Supply and general manager of the Athens, Tenn., utility board. Mr. Usry, we're delighted to see you today and if you'd be kind enough to introduce your colleagues there, I think I know all of them, but we might hear from them for the record.

STATEMENT OF GEORGE H. USRY, GENERAL MANAGER, ATHENS, TENNESSEE UTILITIES BOARD, AND CHAIRMAN OF THE POWER SUPPLY COMMITTEE OF THE TENNESSEE VALLEY PUBLIC POWER ASSOCIATION, ACCOMPANIED BY JOHN COLLIER, BOARD MEMBER, CAINEY FORK CO-OP; HUGH MILRAINEY, GENERAL MANAGER, CAINEY FORK CO-OP; AND JERRY CAMPBELL, EXECUTIVE DIRECTOR, TENNESSEE VALLEY PUBLIC POWER ASSOCIATION

Mr. USRY. We appreciate the opportunity to testify today at this hearing because of the vital issue to our distributors of power.

On my left here we have Mr. John Collier; he is a board member from the Cainey Fork Co-op; Mr. Hugh Milrainey is the general manager of the co-op; and on my right is Jerry Campbell, he's the executive director of the Tennessee Valley Public Power Association.

PARTNERSHIP BETWEEN TVA AND NONPROFIT ELECTRIC POWER SYSTEMS

We do not want to take up a lengthy period here to testify at this hearing, we just want to put in the record our interest is in the Tennessee Valley Authority's debt ceiling request that is before Congress at this time.

To give you a little background, and the others a background into this hearing, the role of the 160 power distributors in the valley is one of longstanding partnership that goes back four decades. TVA being a Federal corporation and us the distributors being locally owned and locally managed electric distribution systems form this partnership. This has been, for the length of TVA's service in the valley, a "division of labor." We serve the customers and TVA provides the power that we use. The 110 municipal distributors and 50 rural electric cooperatives are governed by boards of directors and are appointed on a local basis and represent more than 1,000 board members.

Nowhere else in the Nation is there such a partnership of nonprofit electric power systems—a Federal agency generating and transmitting the electricity, and the nonprofit municipal and rural cooperatives distributing the power at retail to more than 8 million users.

TVA acts under the act of Congress passed in 1933, several times amended. The local power systems—municipal and rural cooperative utilities—are authorized under State law, and we have contracts with TVA for the purchase of the electric power at wholesale.

These 160 municipal and rural electric cooperatives represent sizable operations, with combined annual revenues of more than $1.5 billion, and assets of more than $2 billion.

They are located in parts of seven States; Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia. These also include the major cities in Tennessee, Alabama and other States.

TVA'S IMPACT ON REGIONAL ECONOMY

We have good reason why that TVA's future power supply is of overwhelming importance to the local electric power systems represented by the Tennessee Valley Public Power Association. First of all, TVA is the sole power supplier to these 8 million people. We are totally dependent on their ability to supply that power. These 160 locally owned power distribution systems last year paid TVA more than $1¼ billion for electricity. That's nearly two-thirds of TVA's total income.

We, as distributors of the cost of wholesale power that we collect from our customers pay 80 cents on every dollar to TVA for that cost of power.

The locally owned power distribution systems are vitally affected by TVA's policy decisions—especially those that impact on the cost of electric service, and on adequate supply. Paying rising rates is highly undesirable; not having enough electrical energy to keep the lights on would be much worse.

Because of the division of repsonsibility between TVA and the local power distribution systems, it is the 160 municipal and rural cooperative electric systems that deal directly with the electric consumer. When TVA modifies the wholesale rate schedules, it is the local distributor who must pass that rate change on along to the retail consumers in their local communities. When TVA issues bonds or notes for expanding electric generation and transmission, it is the power revenues from the local power distributors' retail customers that represent the primary support for those bonds. If TVA does not have enough generating capacity to supply all of the region's power needs, it is the local distribution systems that must curtail service to the customers.

Thus, TVA policies concerning electric power must be implemented by 160 municipal and rural cooperatives throughout the States.

In summary, these 160 locally owned, nonproft electric distribution systems—operated in parts of 7 States by municipals and rural cooperative utilities—are totally dependent on TVA for their wholesale power supply, and are by far the largest purchasers of power, supplying nearly two-thirds of the TVA income.

ADEQUATE ELECTRICITY ESSENTIAL TO REGION'S ECONOMY

Adequate power is essential to the region's future. Our position concerning the adequacy of TVA's future power supply is simple and straightforward: we want the people of the Tennessee Valley to have enough electric power so the lights go on when they flip the switch. Our job, as consumer-owned electric utilities, is to keep the lights on, and to provide modern electric service to our communities. We have long-term contracts with TVA for the kilowatts of power to keep the lights on in our cities, towns, and rural areas. We expect TVA to honor those contracts by having enough power, day after day, month after month, so we, the local distributors, can keep the lights on.

We request the Members of the Congress from the Tennessee Valley to serve as leaders in encouraging prompt passage of legislation to increase TVA's borrowing authority from $15 billion to $30 billion, as requested by the administration. We urge the valley Senators and

Representatives to serve as missionaries in explaining to the rest of the Nation the urgent need for adequate power supply in this region, so the area can continue to grow and not suffer economic stagnation.

We do not appear here today as experts on load forecasting for electric utilities. Experts can differ, as evidenced by the testimony that's already been presented here today.

Our conclusion is not complicated. It is that if we are to err in forecasting future electrical loads, we should err on the side of having enough power, so the lights and heat will stay on in the homes, so business and industry can grow and expand, providing more jobs for the region, so the valley can meet the promise of an expanding economy at a faster rate than the national average.

FUTURE POWER SUPPLY

The Electric Power Research Institute, in an important study last year, reached this conclusion about planning for future power supply, and I quote:

> Specifically, the rate-paying consumer is better off if the utility guesses too high an expansion rate than too low. It is mainly due to the customer outage costs.

Rene Males, a division director of the Electric Power Research Institute, said in a speech last year:

> The project clearly indicates that electric systems should have more reserve capacity than indicated by traditional system planning analyses. This stems from including demand uncertainty and outage costs in the planning decision. At a time when utilities are having a difficult time licensing, building, and paying for new capacity, additional capacity requirements are hardly a blessing. However, the consumer is depending on us to provide an adequate, reliable supply of electric energy today, as well as a decade from now. Moreover, the rate-payer expects utilities to build a system that minimizes the customer's costs.

The message of this study by the respected Electric Power Research Institute is clear: the consumer and the community, are better off if load estimates are too high than too low.

ELECTRICITY SHORTAGE MORE COSTLY THAN OVER-ABUNDANCE

A related message is that while it costs money to build new powerplants—especially in today's climate of rising costs and costly delays, there is a potentially greater cost to the consumer and to society: running out of power. It costs more to run short of power than to have an abundance of power. Because if there isn't enough power, lifestyles change, jobs are cutback, standards of living reduced, and society slowed.

POWER FOR FUTURE REQUIRES PLANNING TODAY

The only time to plan for enough power for 1990 is today. If we wait any longer, there will likely not be sufficient time to bring new needed power facilities on line. So now is the time to extend TVA's borrowing authority. Tennessee Valley Public Power Association—whose member utilities provide electricity to more than the 8 million people in the States—urges this committee and the Congress to pass legislation quickly to give the Valley the assurance of new jobs and a rising standard of living.

Thank you.

Senator SASSER. Thank you, George.
[Statement of Mr. Usry follows:]

PREPARED STATEMENT OF GEORGE H. USRY, GENERAL MANAGER, ATHENS, TENNESSEE UTILITIES BOARD, AND CHAIRMAN OF THE POWER SUPPLY COMMITTEE OF THE TENNESSEE VALLEY PUBLIC POWER ASSOCIATION

My name is George H. Usry. I am general manager of the Athens, Tenn., Utilities Board, a municipally owned electric utility serving about 10,000 electric meters. In addition, I am also chairman of the Power Supply Committee of the Tennessee Valley Public Power Association, a regional association of the 160 municipal and rural cooperative electric systems that purchase their entire wholesale power supply from the Tennessee Valley Authority (TVA).

We understand that this hearing relates primarily to the need for future electric power supply for the Tennessee Valley. The consumer-owned electric distribution systems in the Tennessee Valley are deeply concerned about future electric power supply, and strongly in favor of adequate supply to meet the growing needs of the region.

BACKGROUND INFORMATION

Let me provide brief background information on the role of the 160 locally owned electric power distribution systems represented by the Tennessee Valley Public Power Association.

In the Tennessee Valley, for more than four decades electric power has been the product of a partnership between the Tennessee Valley Authority (TVA)—a regional Federal corporation—and locally owned, locally managed electric distribution systems. Ever since TVA was created in 1933, there has been a "division of labor," with TVA responsible for generating and transmitting the electric power via a regional transmission network; and with the local delivery of that electricity to the ultimate consumer—the homes, farms, businesses, and industries—in the hands of consumer-owned electric utility systems: 110 municipal electric systems and 50 rural electric cooperatives.

Nowhere else in the Nation is there such a partnership of nonprofit electric power systems—a Federal agency generating and transmitting the electricity, and nonprofit municipal and rural cooperative electric systems distributing the power at retail to more than 8 million users.

TVA acts under an act of Congress passed in 1933, and several times amended. The local power systems—municipal and rural cooperative utilities—are authorized under State law, and have contracts with TVA for the purchase of electric power at wholesale.

These 160 municipal and rural cooperative eletcric systems represent sizeable operations, with combined annual revenues of more than $1.5 billion, and assets of more than $2 billion.

They are located in parts of seven States, including Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia. They include major Tennessee cities such as Chattanooga, Knoxville, Memphis, and Nashville.

THE DISTRIBUTORS' STAKE IN ADEQUATE ELECTRIC POWER SUPPLY

Here are reasons why TVA's future power supply is of overwhelming importance to the local electric power systems represented by the Tennessee Valley Public Power Association.

(*a*) TVA is the sole wholesale supplier of electricity to those 160 municipal and rural cooperative electric systems, which provide electric power at retail to more than 8 million people in parts of seven States. These locally owned electric distribution systems, then, are at present totally dependent on TVA for their wholesale power service.

(*b*) These 160 locally owned power distribution systems last year paid TVA more than $1¼ billion for electricity—or nearly two-thirds of TVA's total income from the sale of electricity. These local power systems are, by far, the largest purchaser of TVA electric power. These local utilities—and their retail customers, who pick up the bill ultimately—are directly affected by TVA's policy decisions.

The municipal and rural cooperative electric systems in the Tennessee Valley pay TVA nearly four times as much money for electricity as do TVA's Federal agency customers, and about 3½ times as much as TVA's directly served industrial customers.

(c) The cost of wholesale power from TVA makes up about 80 percent of the total cost of supplying electric power at retail to the Valley's power users. To restate this fact, about 80 cents of every $1 of expenses incurred by the Valley's 160 municipal and rural electric systems goes for buying power at wholesale from TVA.

These locally owned power distribution systems are vitally affected by TVA policy decisions—especially those that impact on the cost of electric service, and on the adequacy of supply. Paying rising rates is highly undesirable; not having enough electrical energy to keep the lights on would be worse.

(d) Because of the division of responsibility between TVA and the local power distribution systems, it is the 160 municipal and rural cooperative electric systems that deal directly with the electric consumers. When TVA modifies its wholesale rate schedules, it is the local distributors who must pass that rate change along to the retail consumers in their local communities. When TVA issues bonds or notes to expand its electric generation and transmission system, it is the power revenues from the local power distributors' retail customers that represent the primary support of those bonds. If TVA does not have enough generating capacity to supply all of the region's power needs, it is the local distribution systems that must curtail electric service to consumers.

Thus, TVA policies concerning electric power must be implemented by the 160 municipal and rural cooperative electric systems.

To summarize, then:

These 160 locally owned, nonprofit electric distribution systems—operated in parts of seven States by municipalities and rural cooperative utilities—are totally dependent on TVA for their wholesale power supply; are by far the largest purchaser of TVA power, supplying nearly two-thirds of TVA's total income from the sale of electricity; spend on TVA power supply about 80 cents out of every $1 of their total expenses in operating their locally owned electric systems; and are the means by which TVA power policies are implemented, in day-to-day contact with retail electric consumers.

ADEQUATE ELECTRIC POWER IS ESSENTIAL TO THE REGION'S FUTURE

Our position concerning the adequacy of TVA's future power supply is simple and straightforward: we want the people of the Tennessee Valley to have enough electric power so the lights go on when they flip a switch. Our job—as consumer-owned electric utilities—is to keep the lights on, and to provide modern electric service to our communities. We have long-term contracts with TVA for the kilowatts of power to keep the lights on in our cities, towns, and rural areas. We expect TVA to honor those contracts by having enough power, day after day, month after month, so we, the local distributors, can keep the lights on.

We expect the Members of the Congress from the Tennessee Valley to serve as leaders in encouraging prompt passage of legislation to increase TVA's borrowing authority from $15 billion to $30 billion, as requested by the administration. And we urge the Valley Senators and Representatives to serve as missionaries in explaining to the rest of the Nation the urgent need for adequate power supply in this region, so the area can continue to grow and not suffer economic stagnation.

I do not appear here today as an expert on load forecasting for electric utilities. Experts can differ, as evidenced by the old saw that if all the world's economists were laid end to end, they would no treach a conclusion.

Our conclusion is not complicated. It is that if we are to err in forecasting future electrical loads, we should err on the side of having enough power—so the lights and heat will stay on in homes; so businesses and industry can grow and expand, providing more jobs for the people of the region; so the Valley can meet the promise of an economy expanding at a faster rate than the national average.

In 1958—21 years ago—the municipal and rural cooperative distributors of TVA power served 1.5 million customers, and distributed 17.5 million kilowatt-hours of electricity. In the past year the distributors served about 2.6 million customers (meters)—an increase of well over 1 million meters. And total kilowatt-hour sales of the distributors amounted to more than 70 billion kilowatt-hours—more than four times as much electricity as used 21 years ago.

Another 21 years will take us to the year 2000. By that time this Valley will likely need the electricity to serve at least another 1 million homes, farms, businesses, and industries. And the use of electricity will undoubtedly continue to

grow in our complex, automated society. To plan otherwise is foolhardy and shortsighted.

The Electric Power Research Institute, in an important study last year, reached this conclusion about planning for future power supply:

"Specifically, the ratepaying consumer is better off if the utility guesses on too high an expansion rate than too low. This is mainly due to the customer outage costs."

Rene Males, a division director for the Electric Power Research Institute, said in a speech last year:

"The project clearly indicates that electric systems should have more reserve capacity than indicated by traditional system planning analyses. This stems from including demand uncertainty and outage costs in the planning decision. At a time when utilities are having a difficult time licensing, building, and paying for new capacity, additional capacity requirements are hardly a blessing. However, the consumer is depending on us to provide an adequate and reliable supply of electric energy today, as well as a decade from now. Moreover, the ratepayer expects utilities to build a system that minimizes the customer's costs."

The message from this study by the respected Elecric Power Research Institute is clear: the consumer—and the community—are "better off" if load estimates are too high than too low.

A related message is that while it costs money to build new powerplants—especially in today's climate of rising costs and costly delays—there is a potentially greater cost to the consumer and to the society: running out of power. It costs more to run short of power than to have an abundance of power. Because if there isn't enough power, lifestyles change, jobs are cut back, standards of living reduced, society slowed.

The only time to plan enough power for 1990 is today. If we wait longer, there will likely not be sufficient time to bring new, needed power generating facilities on the line. So now is the time to extend TVA's borrowing authority. The Tennessee Valley Public Power Association—whose member utilities provide electricity to more than 8 million people in parts of seven States—urges this committee and the Congress to pass legislation quickly to give the Valley the assurance of new jobs and a rising standard of living.

As a manager of a municipal electric utility, my job is to keep the lights on in my community. I am confident that members of this Committee want to keep the lights out, too. If TVA's borrowing authority is not extended in a timely fashion, and there is not enough electricity to power the Tennessee Valley, no responsible official wants to be identified as the person who turned the lights off. Some persons today who do not favor additional borrowing authority for TVA are not in positions of responsibility, and if the lights go out a decade from now, those critics will not be held responsible. The job of keeping the lights on is that of responsible legislators, Federal officials, and local utility managers.

We look to a responsible agency, TVA, to make the power load forecasts for which it will still be responsible by the year 2000. We look to this committee for the action that will expedite additional borrowing authority to enable TVA to meet this Valley's growing power needs.

Senator SASSER. George, do your distinguished colleagues there, Mr. Milrainey or Mr. Collier, wish to make any statement?

Mr. MILRAINEY. I don't think so, Senator. I, personally, am glad to be here to see you again.

STATEMENT OF HUGH MILRAINEY, GENERAL MANAGER, CAINEY FORK CO-OP

IMPACT OF UNDERESTIMATING FUTURE POWER REQUIREMENTS

George's statement very clearly, I think states the position of the Tennessee Valley Public Power Association, of which I am a vice-president. I think we're very concerned about the power supply; I think we support the TVA position very firmly. We know that projecting the future is very difficult but we are toying around with something that is very important to the lives of our people. I recall—you may be

mindful of a few years back when the coal strike, when it looked like we'd have a shortage of power, a lot of chaos in the communities, in the industrial communities and whatnot. I think this really bears up our fear of the future if we do underestimate the needs.

And again, I thank you and I enjoy seeing you.

Senator SASSER. Mr. Collier, you wish to make a statement?

STATEMENT OF JOHN COLLIER, BOARD MEMBER, CAINEY FORK CO-OP

IN-DEPTH STUDIES NEEDED FOR PROVIDING FUTURE POWER NEEDS

Senator Sasser, it's an honor to be here. I didn't plan to be here, but I'm here.

It's real interesting. I'm a consumer, as well as setting up policy as a director in a co-op. Our interest is a sufficient supply of energy at the lowest cost. I think we're all in a glass bowl; I think the Freemans are, you are, and everybody else in a management position is. It seems like it took a short time in this position, but I do think the TVA Board should be as economical as possible in their cost overruns. I do think that the public, the consumers—since TVA is the only distributor of power in this area—do expect them to provide sufficient energy to turn the lights on, as George said, and to provide us with the luxuries. I can remember back 40 years ago, and it's a different situation than it was 10 years ago, and I don't think anybody could look very far into the future to see what it's going to be in the next 10 or 20 years. And anybody who has kept up with the papers and television knows that not only this country, but all the countries are in quite a bit of turmoil. And I think that the lawmakers and the TVA Board, should do in-depth studies of providing this area with the proper power to provide the necessities, what have become the necessities of the South.

Thank you, Senator.

Senator SASSER. Thank you, Mr. Collier, and Mr. Usry and Mr. Milrainey. Thank you for appearing here today and your remarks, of course, will be incorporated fully in the record. Thank you very much.

The next witness is Mr. Charles H. Wilson of the Tennessee Valley Energy Coalition. Mr. Wilson.

I presume you're here to testify in favor of this $15 billion, Mr. Wilson.

Mr. WILSON. Your presumption is not well taken, Senator.

Senator SASSER. Well, it will be interesting to hear another view.

Mr. WILSON. I'd like to introduce on my left, Miss Louise Gonfree Gonslow and on my right, Reverend Bill Troy, who are colleagues of mine.

Before I start, I'd like to say, we would have had a lot more people here, the residential group, if they'd had enough money to buy gasoline and pay their parking bill, after paying their electric bill this month. So that's one reason why we didn't have any more people here representing our group as far as those that really bites the difference.

STATEMENT OF CHARLES H. WILSON, TENNESSEE VALLEY ENERGY COALITION AND THE NATIONAL COUNCIL OF SENIOR CITIZENS, ACCOMPANIED BY LOUISE GONFREE GONSLOW AND REV. BILL TROY

Mr. WILSON. My name is Charles Wilson and I am here today representing the Tennessee Valley Energy Coalition, and the National Council of Senior Citizens, which is a member of that coalition. The Tennessee Valley Energy Coalition is a newly formed organization comprised of many various constituencies in the Valley; senior citizens, church, women, Appalachians, environmentalists, people on low and fixed incomes, rural and community groups. All of these interests have gathered together to respond in unison to the many rate issues which affect our security and well-being.

The ratepayers of the Tennessee Valley will bear the brunt of any decision made about TVA's debt ceiling, and thus should have every legitimate right to be heard during these discussions on that decision. We thank you, Senator Sasser, and the other committee members for recognizing that reality and permitting citizens' testimony during these hearings.

RATIO OF INCOME TO UTILITY COSTS

In 1975 TVA went to Congress to increase its debt from $5 billion to $15 billion. Today 22 percent of our electric bills pay for the $650 million interest payment TVA must pay on the $7 billion it has already spent for its nuclear power construction program. Already a great number of our people on fixed and low incomes spend two-thirds of their monthly income for electric bills. For most retired people, utility bills range from 10 to 70 percent of their monthly income.

TVA FINANCIAL CONDITION DETERIORATING

By 1981 the ratepayers will be paying over $1 billion to meet the interest costs on the $15 billion TVA will have spent on its power construction program. These interest payments do not even touch cost on the debt retirement. The $1 billion interest charge is roughly two-thirds of the original cost of all the dams and reservoirs built by the agency since 1933. TVA's financial condition is deteriorating quickly as the utility plunges ever deeper into debt.

TVA is urging Congress to raise its debt ceiling to $30 billion. It claims it needs the funds to complete the 14 nuclear power units currently under construction, plants which have already incurred 100 to 200 percent cost overruns. TVA claims it needs additional capacity even though the recent GAO report concludes that TVA will not need additional capacity through the end of the century.

Senator SASSER. Mr. Wilson, you state that—if I may interrupt you just a moment. You state it claims it needs the funds to complete 14 nuclear power units currently under construction. Is that a misprint or do you mean to say 14 there?

Mr. WILSON. I couldn't hear you.

Senator SASSER. I say, you say, in the second paragraph of your statement, second sentence, beginning, "It claims it needs the funds to complete 14 nuclear power units currently under construction." Do you mean to say 14 there or is that a misprint? I think there's six——

Miss GONSLOW. There are 14 units.

Reverend TROY. At six sites.

Mr. WILSON. Six sites.

Senator SASSER. Oh, OK, I get you now. The difference between the units and the sites. Right, OK. Excuse me.

REVERSE TREND OF INCREASED ELECTRIFICATION

Mr. WILSON. The Tennessee Valley is already the most highly electrified region in the United States, and, thus the world. Increased electrification means automation and loss of jobs, a fact many unions are beginning to recognize. TVA has a moral responsibility to the citizens of the valley to reverse this trend toward increased electrification; however, TVA, pretends that the situation is out of their control and that it can only meet the demand.

By building ever more capacity, is TVA meeting demand or is it creating it? How does TVA fit into the plans of a national grid? Will TVA be the supplier of power that is cheaper because of its ability to get low interest Federal loans? More and more ratepayers are coming to the realization that the Tennessee Valley is being turned into an energy colony for the benefit of other utilities, while we, the ratepayers, must pay for the costs of construction and interest and bear the environmental burdens associated with coal and nuclear generation. TVA ratepayers are being forced by TVA to subsidize other utilities when TVA becomes an exporter of power. Already, both Freemans have admitted that when all the nuclear plants are on line, TVA will have such an excess of generating capacity that it will be able to sell power to other utilities.

HISTORIC COMMITMENT TO WELFARE OF VALLEY CITIZENS

Ratepayers have not been privy to any of these TVA decisions and so our opinion on these matters has not been heard by TVA nor will TVA probably ever ask for it. Let us state for the record right now, that TVA was established as a regional entity to develop the resources of the Tennessee Valley. TVA must be encouraged to remember its historic commitment to the welfare of the valley citizens. We oppose its recent trend toward considering itself an agency with primarily a national responsibility. Such an orientation is new to TVA and very dangerous and expensive for its ratepayers.

ALTERNATIVE METHODS TO DECREASE ELECTRICITY CONSUMPTION

Conservation, solar energy, load management, rate restructure are all options which TVA could utilize to decrease current needs for power consumption. Indeed, if TVA was sincerely interested in the interests of the valley and in demonstrating to the Nation that society can free itself from ever larger energy fixes, such options would become central to TVA planning. The power needs of the valley could be met through alternative means which might even make it unnecessary to

complete the Yellow Creek, Phipps Bend, and perhaps even Hartsville. The Tellico saga taught us a lesson; we don't have to complete an idea if it's not well thought through to begin with. Such a course of action would save the ratepayers billions of dollars and end the necessity of raising TVA's debt ceiling.

MORE CITIZEN PARTICIPATION IN PLANNING PROCESS

However, such are not TVA's current goals, whatever they are. That, by the way, is a great problem for us citizens. TVA says it always has these plans and studies, but these documents are never released to the public to permit our study and educated response until just before they are implemented. The TVA seems afraid to involve citizens in such vital decisions as power construction plans. It announces its plans and expects the ratepayers to pay. The coalition urges Congress to encourage TVA to open itself to citizen participation in its planning processes so that people it so drastically affects have the guaranteed opportunity to have our opinions heard and considered before decisions are made. We don't need to remind this committee that TVA is a self-regulating agency with no other watchdog agency other than Congress itself. It is perhaps time to extend democracy to the valley, Tennessee Valley, and change that cumbersome and unrepresented mechanism.

INCREASED DEBT CEILING AN INVITATION TO BANKRUPTCY

The TVA was established as a yardstick so that other regions of the country and other utilities could learn from the TVA model. Are we to gather from these events that the model being proposed for the country is that, ever-increasing debt is the way to go? TVA has not been fiscally responsible. Now it wants the debt ceiling raised to $30 billion. Such deficit spending breeds inflation. Moreover, the increase of the debt ceiling will bring TVA that much closer to default, a circumstance that will place the entire debt into the hands of the Federal Government.

TVA has already admitted that with the completion of all of its nuclear units, it will have more power than it needs. The GAO report contends that TVA doesn't need additional capacity until the end of the century. TVA has only begun to experiment with conservation, solar energy, and load management which will decrease the demand for existing capacity.

FUTURE TVA ROLE

We urge this committee to decide that the TVA debt ceiling not be raised any further and that it suggest to TVA it consider delay of Yellow Creek, Phipps Bend, and Hartsville. It ought to better manage its fiscal resources. Further, we urge this committee to encourage TVA to integrate conservation, solar energy, load management, and rate restructure into its power projections and to demonstrate to the Nation, in its role as a yardstick, how these options can reduce the need for electricity. Finally, TVA's regional nature must be reaffirmed to discourage current trends toward satisfying national energy needs. We here in the valley consider TVA a great potential asset once it

has become responsive to the needs of the valley rather than to its own internal whims or grandiose aspirations.

We need TVA to meet our demands here in the valley. TVA has a moral responsibility to respond to our needs. We need your help to remind TVA of that. We urge you to listen to us.

Thank you.

NEED FOR ADDITIONAL GENERATING CAPACITY QUESTIONABLE

Senator SASSER. Thank you very much, Mr. Wilson.

You had a couple of points in your statement here—TVA has indicated that it doesn't need and will not need additional generating capacity when the nuclear plants are completed and you indicate, I think, both Chairman David Freeman and Richard Freeman have also been quoted as having said this. Can you give us case and verse on that and elaborate on that statement a little bit?

Ms. GONSLOW. Well, there are several statements—I can give you press clippings; send them to you; in which both of the Freemans stated that once all the nuclear plants are on line there will be additional capacity enabling us to sell power out of the region. They have not said that since they have asked for the debt ceiling to be raised.

SUBSIDIZING POWER NEEDS OF OTHER SECTIONS OF NATION

Senator SASSER. Well, as you know, for many years TVA has had interchange agreements with other utilities to buy and sell power and I really don't have any quarrel with that. But I think like you, and I think like most other citizens of the valley, I would be opposed to just willy-nilly selling power as a matter of course to other parts of the country. I don't think that we should have to subsidize other areas for power, and I don't think we should be using our area down here to put electricity on a wire and send it to some place else in the country on a routine basis. That's not what TVA is all about.

Reverend TROY. Senator, can I just make a remark here?

Senator SASSER. Yes, indeed.

FUTURE SUPPLY CAPABILITIES OF TVA

Reverend TROY. As you know, other utilities, particularly with regard to nuclear generation, are holding back on expanding and some of those utilities are within range of buying TVA power. I think Mr. Freeman said today, that the bottom line is that TVA can build a nuclear powerplant for 25-percent less money than anybody else can. That's still quite a bit of money as evidenced by the fact that they want to double that debt ceiling in one full swoop. It just raises the question in your mind—and I think that that's one of the various strong points that we want to make with you today—that while they have not said they intend to supply power or to be a power supplier for other areas of the country, that if the debt ceiling is raised as they wish, the numbers make it look as though they will be in a position to do that. And if oversight is not exercised by the Congress as it will be if our coalition has anything to say about it via local citizens in the Tennessee Valley, then the capacity is there to do that whether or not anybody intends for it to happen or will say that they intend for it to happen. The question is, why should we be able to afford it if other people can't?

TVA GROWTH PROJECTIONS NEED MORE STUDY

Ms. GONSLOW. And on the subject of TVA projections, the variables that they use in the cranking out what they would need, do not include restructuring, the effects of restructuring upon the rates. It assumes that there's going to be approximately less than 1 percent of solar energy by 1990 to reduce the load and does not deal with the issues of load management. So their projections are still high because they don't consider all the possible conservation practices that they could implement, and I think there really needs to be more study, at least, on this whole issue of how much power TVA needs to supply the valley. I think there needs to be a great deal more public education on this issue and public input since the ratepayers are the ones who are going to bear the brunt of it. And I agree right now that Congress makes decisions but it's the citizens who bear the responsibility of that decision and I urge that we don't rush this through because it's not a decision that will disappear overnight—we're going to have to live with it here.

EFFECT OF RATE INCREASES ON REGION

Mr. WILSON. Senator, I'd like to say one thing, that maybe most of the people in this room today can pay their utility bill, but there's thousands of people out there who can't pay such utility bills with this interest that TVA's going to add on, plus the increase in operation costs that they're going to add on. We urge that people think about the ratepayers.

Ms. GONSLOW. People who receive $280 a month for income are paying $200 utility bills.

Senator SASSER. Well, maybe we struck a blow for liberty today, Mr. Wilson, because these hearings were held on a day when I think the Board was going to meet to consider a rate increase and they had to postpone that because of this particular hearing.

Ms. GONSLOW. Until tomorrow.

Senator SASSER. Maybe we were some assistance——

Mr. WILSON. They just hired an adviser, going to pay him $48,000 a year. Advise them for what? Don't they have no heads on their own shoulders to run this business?

Senator SASSER. Thank you very much for appearing here today and giving us the benefit of your views.

Mr. WILSON. Thank you.

Senator SASSER. The next witness is Mr. John Thomas from the East Tennessee Energy Group.

Mr. THOMAS. With me is Bob Allen, also of the East Tennessee Energy Group.

Senator SASSER. I didn't catch the name.

EXCESS OF ELECTRICITY INCREASES GROWTH RATE OF VALLEY

Mr. THOMAS. Bob Allen.

In response to the question you asked the previous people, David Freeman made a statement in Johnson City, I think in October or No-

vember of last year which stated in effect that there would be growth in the valley for the simple reason that there would be an excess of electricity and that he could not be accused of being a no-growth advocate, he had no control over it. It was issued in a press release by TVA or a copy of that speech was sent out by TVA in October or November last year.

Mr. ALLEN. There was also a press release, if I might add, in I believe it was Saturday's News Sentinel here, talking about the transmission lines being built from the Phipps Bend nuclear powerplant to supply the private utility of Kingsport, Tenn., and also—I forget the name of it, but the private power company in southwestern Virginia.

Mr. THOMAS. Appalachian.

Mr. ALLEN. Appalachian Power.

STATEMENT OF JOHN Z. C. THOMAS, EAST TENNESSEE ENERGY GROUP, ACCOMPANIED BY BOB ALLEN, EAST TENNESSEE ENERGY GROUP

VOICE OF CITIZENS IGNORED BY TVA DECISIONMAKING PROCESS

Mr. THOMAS. I'm John Thomas from the East Tennessee Energy Group. We thank you for opening up this hearing to citizen participation and for this opportunity to testify before the subcommittee. The voice of citizens is too frequently ignored in the Tennessee Valley Authority's decisionmaking process. The so-called public meetings on the fuel adjustment clause or the rate reviews are merely comment periods on decisions already taken, and thus because they are so meaningless they are poorly attended. At the moment there is no mechanism for broad citizen input to be incorporated in the decision on whether to increase TVA's debt limit ceiling. This hearing is the only chance citizens will have to have input on that decision. We appreciate this opportunity but it is not enough. That, however, is not your fault.

You have listend today to much testimony on TVA's growth projections. Unfortunately such projections are an inexact science, to say the least, and generally can be made to prove whatever you want to prove. Although such projections are important in deciding whether to raise TVA's debt limit ceiling, there are other considerations that must be taken into account.

IRRESPONSIBLE FINANCING

In 1975, TVA approached the U.S. Congress and had its debt limit ceiling raised from $5 billion to $15 billion. In less than 4 years they have contracted to spend that money, and they are now asking you to further increase their borrowing power from $15 billion to $30 billion. To what end? That is a most important question since TVA has indicated no specific uses for the money except for a couple of billion dollars necessary to finish their current construction commitments. There have been hints that another nuclear facility is on the books and the General Accounting Office report mentions the possibility of at least one more pump storage facility. The nuclear plant was in the budget

for fiscal year 1978 but was omitted from the 1979 budget. Thus we are left with over $10 billion for which there is no explanation other than TVA's projected growth projections. This is irresponsible financing especially since TVA undoubtedly has some idea of what type of future capacity they are planning. If they do not have such plans they are even more irresponsible.

ECONOMIC IMPACT OF NUCLEAR OPTION ON COAL COUNTRY

TVA's last increase was to fulfill its commitment to nuclear power and we are fearful that, that is what the current request for additional borrowing authority will be used for. In this region, in this day and age, such a commitment goes against the best interest of the people for two reasons. This is coal country and to embrace a technology that has as its end result the retiring of coal-fired plants is not in the best interests of Appalachia's economy. By going nuclear and ignoring coal supplies TVA is doing incredible damage to the future job market in this area. That and that alone is sufficient grounds to reconsider financing TVA's expensive nuclear option.

Equally as important is the interest costs for TVA's nuclear commitment. This increasingly is going to become a greater and greater burden on the valley's citizens, especially those on low or fixed incomes. In the rate review coming up, the interest expense for fiscal year 1979 is projected to be $655 million as compared to approximately $487 million in 1978 and $384 million in fiscal year 1977. The projected interest expense for fiscal year 1979 is only slightly less than half of TVA's projected fuel expense. One would almost think they are literally burning money. Almost all of this increase can be attributed to TVA's nuclear construction program. By 1981 when TVA at the most will have on line three nuclear plants, the interest expense is expected to reach more than $1 billion annually. Before subjecting the Valley's ratepayers to this burden, careful consideration should be given to the need for increasing the debt limit ceiling.

EXPORT OF ELECTRICITY

There are persistent rumors that part of TVA's excess capacity, some of which will be built with the increased debt limit ceiling, will go for the export of electricity. We have been exporting energy for the last 20 years in the guise of enriched uranium, and we are tired of being an energy colony. Regardless of how you look at it, it costs us more than we get in return. It costs our environment, our jobs, and our lifestyle. Certainly any increase in the debt limit ceiling should be tied to a requirement that energy produced in the Valley will stay in the Valley.

Before raising TVA's debt limit ceiling you should carefully review TVA's past practices, especially those for its nuclear program. In light of the debate over TVA's current growth projections you consider the ones used to justify TVA's last three nuclear plants—given that those projections were a lot less sophisticated than the ones under review.

REVIEW OF COST-BENEFIT ANALYSIS

Furthermore the cost-benefit analysis for the nuclear plants should be reviewed to see if they are still viable. TVA is notorious for doing a poor job of projecting costs. This is amply demonstrated in the cost overruns for TVA's nuclear facilities. For the Sequoyah plant it is now 227 percent; for Watts Bar it is 115 percent; for Bellefonte it is 100 percent; for Hartsville it is 122 percent; and for Browns Ferry, the only plant operating, it is 135 percent. TVA's last two plants have a current cost overrun of 13 percent each but then construction has barely started on Phipps Bend and Yellow Creek. Although a lot of this increase is due to inflation that is no excuse since TVA always claimed it had taken that into consideration in its cost-benefit analysis.

As an aside, let me say that a lot of the above mentioned problems might not loom so large in the future since TVA is now under new leadership. Regardless of future plans to correct the inequalities of the past, such previous mistakes should not be allowed to survive merely because the projects have been started. By getting the projections and cost-benefit analysis to come out as they wished, the old TVA was able to get questionable projects authorized.

PUBLIC PARTICIPATION IN TVA'S DECISIONMAKING PROCESS

My final point deals with public participation in TVA's decisionmaking process—effective public participation. Before TVA's debt limit ceiling is raised there must be public education and hearings. TVA said in January that none were planned, that none were needed because they did not have any other option except to ask for the increase. There are other options, some of which have been pointed out today. And certainly before the debt is increased, those of us that are going to have to pay for it ought to know how much it is going to cost, and what it is going to be used for. And this time we want understandable figures and information that reflect what is going to happen, not what TVA wants to happen. After all, in the end we are the ones that are going to have to live with whatever results. This is our home and we cannot move away or retire and leave the mess for someone else to clean up.

If TVA is as serious about its public participation program as their press releases say, then this is a good opportunity to educate the people of the Valley as to TVA's plans and problems. Then they could have meaningful public participation and a decision could be made by all the people of the Valley, not just a few. Maybe the increase is necessary but we have no evidence that it is except to be told so. That is not good enough. If TVA is not serious about citizen action, then the whole new character of the agency is a sham. In fact, the new TVA is beginning to look and sound like the old TVA in different clothes.

Thank you.

Senator SASSER. Gentlemen, thank you very much and we appreciate your participation today and getting your views.

Mr. THOMAS. Thank you.

Senator SASSER. Our next witness is Mr. Will Skelton, representing the Sierra Club.

STATEMENT OF WILL SKELTON, TENNESSEE CHAPTER, THE SIERRA CLUB

Mr. SKELTON. Senator, as indicated, I'm Will Skelton; I appreciate the opportunity to be here. I'm appearing on behalf of the Tennessee chapter of the Sierra Club, which is a unit of the national Sierra Club. I want to try to be brief because I'd like for you to be able to enjoy some of this beautiful Tennessee weather we're having, which is in sharp contrast, I understand, to Washington, today anyway.

Senator SASSER. It is, indeed.

CLEAN AIR SETTLEMENT

Mr. SKELTON. First, before I get into the talk which I have given you all a copy of, as far as the clean air settlement, the Sierra Club was a party to that lawsuit, I was chairperson of the Tennessee chapter at the time the settlement was approved and was coordinating with the lawyer for us as far as the approval, and based upon talking with him—I don't know the details—but based upon talking with him, we gave a lot too. It was not simply TVA giving; it was a fair settlement from both sides. And that's generally what I hear from everybody that's informed. It's a very complex issue, I'll have to say that, because I don't understand it, but the people who are in a position to know, our lawyer, staff for other Congressmen, Senators, that kind of thing, people who are in a position to know feel it's a pretty fair settlement, so I don't think it's a settlement that brickbats should be thrown at unnecessarily.

I do agree and support strongly, and we do, the Sierra Club, your oversight of TVA. David Freeman and Richard Freeman, they've done a lot in changing the attitude of TVA toward the people in the valley—there's no question about that—but there's still things to be done and there's still a need for you all to take a look at them every now and then, and that's good.

DEBT CEILING INCREASE TO EXERCISE NUCLEAR OPTION

As far as the debt ceiling increase, TVA, of course, has long, as indicated before, has been a yardstick utility for a long time. I feel one of the big reasons for that is the natural resources that we've had in the Tennessee Valley. Originally, TVA had water power. We had a lot of rivers and they dammed those and that was cheap electricity. Then when that ran out, when they dammed all the rivers, they turned to coal. Again, we had lots of coal, massive reserves of coal, enough to last 200 years or so, and we still have that coal, of course, but for some reason they got away from coal and started turning—we believe, unfortunately—to nuclear in the last—less than 10 years. And they're turning not just slowly, it's not a slow turn, it's a complete about face from one of coal reliance to nuclear reliance for generation. As indicated before, they are constructing six nuclear powerplants; they've got one already on line—when it's on line. The down time, of course, as you know, is pretty high on nuclear powerplants. And the nuclear program really is the primary reason for their wanting to borrow up to $30 million. I shouldn't confuse that because that's a lot of difference.

The nuclear program and nothing else. It comes down to that. We feel that they are overemphasizing this nuclear option, that they're going to become a yardstick on the other side of the coin. They're going to be a yardstick on the high side if they don't watch out, rather than the low side.

The reasons we feel this are outlined in the document I gave you there. It's a complex area again, and I can't in 5 minutes certainly summarize it all, but three important reasons why we feel TVA is going the wrong way when they shift from coal to nuclear.

COAL—A VIABLE OPTION

First is that coal is still a viable option. No question about that. There's plenty of coal in the southern Appalachians which would help our economy, not the economy of New Mexico or South Dakota or somewhere like that where they're going for uranium. It will help us, it's there. The acts which you in Congress have passed in the last several years make coal an even more viable alternative. The Surface Mining Act, the Clean Air Act, and the Deep Mining Safety Act, all of those make coal much more viable an alternative, so why the big turn? Why the about face switch to nuclear?

CONSERVATION

Second, conservation. Congress' own investigative arm, GAO, has said that TVA is overemphasizing the demand side of the equation. We agree with GAO, we feel they are overestimating and they also are not emphasizing enough conservation. They need to work on conservation and that can make a difference. It made a difference for a while, and still is to some extent, in the gasoline thing. When we started—when the crisis occurred several years ago, all of a sudden there was a difference in the use of oil for gasoline because people were conserving. They're getting away from that now, unfortunately, maybe they'll have to get back to it.

NUCLEAR OPTION A DISASTER FROM ECONOMIC STANDPOINT

Finally, and most important as I've indicated, the reasons we question TVA's switch is that the nuclear option quickly becoming what we feel is a disaster area from an economic standpoint. Now the Sierra Club, of course, is concerned about nuclear from an environmental standpoint. But I have to point out that very few nuclear powerplants have been stopped for environmental reasons. Now there's a couple of big exceptions, well-publicized by the newsapers and TV's and so forth, but except for the one in New Hampshire, one in California, maybe Hartsville—well, Hartsville is stopped—except for a couple of exceptions, environmental considerations have not stopped nor significantly slowed the construction of nuclear powerplants. I found this out very quickly as far as Phipps Bend is concerned. I was aware of the citizen opposition to that but it got nowhere. There was simply no way to stop that; it went ahead, we did no slow it down one iota.

However, economic considerations are stopping nuclear powerplants. There's really no question about that. Last year only 2 new

nuclear powerplants were ordered, 12 were canceled. So private utilities are quickly realizing that there's problems. I quote—you can quote a bunch of people and there's books coming out all the time on this but William Mooz of the Rand Corp., says, "You have to wonder if nuclear can be competitive." And he's not a strict environmentalist or anything like that. He's talking also primarily of construction costs. If you figure in all these other costs, the cost of maintaining the nuclear powerplants, the increased security problems, the increased skyrocketing cost of fuel, because uranium is going up just like coal—the price is different but it's also accelerating—the cost of decommissioning and the cost of maintaining these plants forever, which literally we've got to do, and that ought to be figured into the cost of them because somebody, the ratepayers are going to have to pay for that. If you figure all those in, nuclear power is really not a bargain when you compare it with coal and other options which are further down the road but are going to be there if we get with it.

Even though you've got this switch from nuclear power by the private utilities, in the midst of all this TVA is, to me, blissfully going ahead with a full-scale nuclear conversion. They seem to really be putting their head in the sand as far as what's going on in the rest of the country as far as the nuclear program. Other countries, some States, Hawaii, Montana, I think just this past election, passed referendums either restricting severely or banning nuclear powerplants. It's happening throughout the world and it's frequently for economic reasons as much or more as for environmental considerations. But in spite of this TVA is going ahead to become the biggest nuclear utility in the world and that's what they want to be, I guess. They want the biggest, which they're getting at Hartsville; they want the most, which they're also geting with the seven that they have planned. And, of course, we're going to have to pay for all this, which will cost more, I think, without any question, than coal would.

TVA'S DEBT OUT OF LINE WITH PRIVATE UTILITIES

So, based on this, I don't want to turn this totally into an antinuclear statement but it is, really, because that's where the increased costs are coming from, the nuclear program. So, because of this, we urge you to vote against and work against any increase in TVA's current debt ceiling. Their debt is already pretty high and probably out of line with private utilities. And I'm no economist but I have calculated some rough calculations based on figures from stockbrokers as to other companies' debts and from TVA based on their debt and so forth. Based on that, for each megawatt of generating capacity, Duke Power has about $177,000 of debt. Southern Co., which is Alabama Power and Georgia Power has $198,000 of debt. And TVA, in pretty sharp contrast, has $266,000 of debt. So TVA's debt right now, and we're not even talking about this over $15 billion, or next year when it's going to go up to $9 billion, TVA's debt is already out of line with private utilities, substantially out of line and it's going to get worse.

The result of all this might be the cancellation of one or more of TVA's nuclear powerplants, maybe the last two, Phipps Bend and Yellow Creek. If so, I think that's good. I think that they can convert

to coal plants and we'll come out better economically. And that's what I'm talking about really is economics.

Let's let TVA economize for a change. They can handle the problems. They're overstaffing in TVA, there are inefficiencies. I'm sure, before you became Senator, you know of those rumors and people talking about how TVA could save money if they would just get rid of the deadwood and that kind of thing. That may be everywhere in the Federal Government, I don't know—I hope not—but it's certainly in TVA. They could economize.

Let's let TVA encourage conservation of energy. They can do a lot more on that. And continue using our coal in the Appalachian district.

INTEREST ON TVA DEBT ONUS TO RESIDENTIAL CONSUMER

Otherwise, $30 billion is just a horrendous figure to think about the taxpayers in Tennessee and the Tennessee Valley paying the interest on, much less paying back the principal. Another calculation, the interest alone if they do get up to $30 billion—of course, they say we won't borrow all that, maybe—but if not, why are they asking for $30 billion? And that's a good question I've got. If they don't need it, why don't they get it as they need it? But they're asking for $30 billion. Anyway, the interest alone on that, assuming that it's borrowed at 8 percent, would be $2.4 billion dollars a year, which is about $1,000 per residential consumer in the Tennessee Valley. And that's not totally accurate because, of course, some of that would be paid by commercial businesses and commercial users of electricity. But still, that gives you an idea, when you're talking about a debt that provides $1,000 of interest a year for every residential consumer. that's a lot of debt repayment, much less the principal. You can't forget repaying the principal, of course.

So, in summary, it's our feeling that TVA, as far as their nuclear power program is not going to economize; their only solution is a solution I hope we've gotten away from—throwing more money at it. Congress in the past has had that attitude; I think they're getting away from it. So hopefully, Congress will restrain TVA's spending and the best way to do that is simpy a proposition 13 in the form of a refusal to increase their debt ceiling. Make them live within their means. Make them live within their means like other private utilities have to do. So we urge you to take a good look at it and not to simply go along with it as Congress has in the past, because TVA wants it.

Thank you, Senator.

Senator SASSER. Thank you, Mr. Skelton.

PREPARED STATEMENT OF WILL SKELTON, TENNESSEE CHAPTER OF THE SIERRA CLUB

My name is Will Skelton and I would like to make several comments on behalf of the Tennessee Chapter of the Sierra Club in connection with the proposed increase in the debt ceiling of the Tennessee Valley Authority. TVA has long been recognized as a yardstick utility for low electric rates, thanks principally to abundant natural resources. That reputation was, in TVA's early days, due to abundant hydro generation capacity, similar to that found on the Columbia River in Washington. When the prime hydro sites proved insufficient, TVA turned to coal generation of electricty and benefited from the Valley's proximity to massive reserves of coal. TVA is now, unfortunately, turning to a third primary source of generating capacity—nuclear.

TVA OVEREMPHASIZING NUCLEAR ALTERNATIVE

TVA is currently constructing and/or plans to construct 6 nuclear power plants, plus Brown's Ferry which is already operational. Their construction is the primary reason for our being here, and the need for TVA to borrow up to 30 billion dollars. We feel TVA is overemphasizing the nuclear alternative to the exclusion of other viable alternatives and, as a result, is sowing the seeds that will make TVA a yardstick utility in the future—but on the high side of the scale this time. Why do we feel this way?

1. Coal continues to be a viable option for the short and middle term future. Coal reserves in the Southern Appalachians are still massive—200 years or so worth. The Surface Mining Act and TVA's finally agreeing that the Clear Air Act applies to TVA reduce significantly the environmental problems of coal. The Mine Safety Act can make deep mining safe, if enforced. New techniques can and will make coal more efficient, safer and cleaner.

2. Conservation can make a difference. Congress' own investigative arm, the GAO, has confirmed TVA's overemphasis on future demand and underemphasis on conservation.

STRAIGHT ECONOMICS KILLING NUCLEAR POWER

3. Finally, and very important, the nuclear option is economically becoming a disaster area. The Sierra Club is, of course, principally concerned with the environmental hazards of nuclear power. However, environmental objections have stopped or slowed the construction of very few nuclear plants, with a few well publicized exceptions. Instead, straight economics is killing nuclear power. William Mooz of the Rand Corporation says regarding price escalation of nuclear power: "You have to wonder if nuclear can be competitive." He is talking principally of construction costs; if you calculate also the increased costs of security at nuclear plants, the skyrocketing cost of nuclear fuel, the cost of decommissioning the plants after 35 years or so, and the cost of maintaining the site and waste material *forever*, then nuclear power is certainly no bargain. Private utility companies are realizing the uncertain economics and, as a result, only two nuclear reactors were ordered in 1978, while twelve were cancelled. For both economic and environmental reasons, numerous states and other countries have severely regulated or banned nuclear power plants. And yet, in the midst or what is certainly a huge question mark over the future of nuclear power, TVA blissfully proceeds toward placing a greater and greater reliance on nuclear power; more than any other large American utility. TVA wants the biggest nuclear power plant, and they want the most nuclear power plants. And, the price tag for this extremely expensive technology will be paid by the consumer, who's had little opportunity to support or oppose the decisions being made by TVA.

TVA DEBT CEILING TOO HIGH

We urge you to vote against and work against any increase in TVA's current debt ceiling of 15 billion dollars, which is probably already too high. TVA's debt is already proportionately higher than most other utilities, which should raise some rather serious questions for Congress. For example, for each megawatt of generating capacity, Duke Power has $177,109.11 of debt. The Southern Company has $198,988.65 of debt, and TVA, in sharp contrast, has $266,360.85 of debt. The comparison will worsen as TVA's nuclear program continues, especially if the debt is raised. In 1979, for example, TVA will have $366,638.06 of debt per megawatt of generating capacity.

If the result of no increase in TVA's debt ceiling is the cancellation of one or more nuclear power plants, so much the better, for the reasons discussed before. Instead, let TVA economize for a change (their overstaffing and inefficiencies are widely discussed and known); let them encourage and even require conservation of energy; and let them continue using our local supplies of coal rather than going to North Dakota or New Mexico for uranium. Otherwise, a 30 billion debt will mean an oppressive burden on the rate payer, and even the 30 billion may not be enough (they told us only a short time ago that 15 billion would be enough). The interest alone on 30 billion dollars at 8% per annum would be 2.4 billion dollars a year, or $1,000.00 per year for every TVA residential customer. Of course, TVA may not borrow the full 30 billion (but they're requesting authority to) and the full interest charge would not be passed on solely to residential customers; however, the magnitude of the rate payer's potential liability is clear.

TVA will apparently not economize itself; their only solution to an obvious problem is to throw more money, our money, at it. Hopefully, Congress will act to restain TVA's spending habit. We support a proposition 13 for TVA in the form of a refusal to increase their current debt ceiling.

Thank you.

Additional Information:

Company	Total generating capacity (megawatts)[1]	Total debt[1]
Duke Power	12,466	2,204,300,000
Southern Co.	23,632	4,702,500,000
TVA	[2] 27,031	[3] 7,200,000,000

[1] Late 1978.
[2] TVA, system capacity publication dated Nov. 9, 1978.
[3] Knoxville Journal, Jan. 29, 1979.

Note: TVA residential customers: 2,400,000.

NO PUBLIC HEARINGS ON REQUEST TO RAISE DEBT CEILING

Senator SASSER. You may have alluded to this, previous witnesses have, about the fact that there have been no public hearings or no citizen participation in the request to raise the debt ceiling by $15 billion. In the questions which I have submitted to Mr. Freeman, in writing for the record, there is a question in which I asked why there had been no citizen participation.

We have statements from the League of Women Voters which they have asked to submit for the record and without objection they will be incorporated into the record.[1]

We also have communications from the Nashville Electric Power Board, which also will be incorporated into the record.[2]

DIFFICULTY IN FORECASTING ELECTRICAL DEMANDS OF FUTURE

Well, since we've heard the last witness today, as I reflect on the information developed at this hearing, I'm struck by the difficulty of forecasting accurately electrical demand in the future. This is, of course, a critical issue because it relates to the need for additional power facilities and that relates, of course, to the rate base as has just been pointed out and that relates to what people pay for electricity. The testimony we have received today has been very helpful to me and very informative. I think it will be helpful and informative to many of my colleagues. We have explored many critical issues today and I intend to study the information we've developed very thoroughly and very carefully. The data developed here will be useful to the Budget Committee in the annual review of the new budget authority requested in President Carter's fiscal year 1980 budget request.

I look forward to continuing to work with the officials of the Tennessee Valley Authority, the General Accounting Office, the University of Tennessee, the Oak Ridge National Laboratories, and other public groups and agencies in guiding TVA to an even greater future, a future that hopefully will be more responsive to the people, a future

[1] See p. 112.
[2] See p. 113.

that will be responsive to reality and a future that will be responsive to the public interest. And I want to thank all of those who testified today and express my gratitude to them and to thank them for their cooperation and their assistance. All have contributed, all have sought to be helpful and all have been helpful, and we appreciate it.

Thank you very much and this hearing is adjourned.

WRITTEN QUESTIONS FROM SENATOR SASSER TO THE GAO, AND THE RESPONSES

POTENTIAL OF INSULATION PROGRAMS

Question 1. I think all of us agree that conservation efforts should be increased throughout the country. The National Energy Plan set a goal of insulating 90 percent of all residences by 1985. The GAO report says this goal will be difficult to achieve, particularly in the TVA area. Why does the GAO paint such a pessimistic picture of the potential of insulation programs?

Answer. We certainly agree that energy conservation is important and efforts should be increased to attain maximum conservation. Consumer decisions to invest in energy conservation are usually based upon economic factors and this is the basic reason we feel the 90 percent goal of insulating all existing residences by 1985 will not be attained in the TVA area. TVA has lower electricity rates than most of the United States which means a longer payback period to recover insulation investments. The TVA region also has mild winters—2,900 heating degree days compared with 4,900 for the Nation as a whole—which would also impact on economic decisions. We pointed out in our analysis of the National Energy Plan (An Evaluation of the National Energy Plan, EMD–77–48, July 25, 1977) that potential problems could inhibit the attainment of the 1985 goals for the country as a whole.

COGENERATION IN THE TVA REGION

Question 2. I am a strong advocate of cogeneration. I cosponsored the Cogeneration and Waste Heat Utilization Act in the last Congress which was eventually incorporated into the comprehensive energy act which became law. I was very impressed with GAO's assessment of the potential use of cogeneration in the TVA area and the Nation. Please elaborate for this hearing the potential of cogeneration in the TVA region.

Answer. We agree that cogeneration is an area with potential to displace generating capacity and cut fuel use not only in the TVA area but throughout the country. As our report points out, cogeneration is generally considered to be most cost effective at boiler sizes greater than 200 MMBTU an hour. We identified 60 boilers this large or larger in the TVA region. Based on the existing capacity of the 200 MMBTU an hour and the larger boilers in the TVA region, the potential capacity for cogeneration is estimated at 7–14 billion kWh/yr. The following table shows projections of this potential to the year 2000 and converts this potential into an equivalent central station capacity.

Year	Cogeneration potential [1] (billions of kilowatt-hours per year)	Equivalent central station capacity [2] (megawatts)
1977	7–14	1,200–2,300
1985	13–20	2,100–3,300
1990	23–26	3,700–4,300
2000	32–41	5,200–6,700

[1] The following rates of electricity generation per million Btu of steam are used: steam turbine=50 kWh, gas turbine =200 kWh, combined gas/steam turbine=300 kWh, diesel=400 kWh. These figures presented in this column represent weighted averages of these technologies. It is assumed that in earlier years greater use will be made of the steam turbine while in later years greater use will be made of the gas and combined turbine systems. For example, the low 1977 estimate assumes all steam turbines while the low 2,000 estimate assumes an average kilowatt-hours per year per million Btu of steam of 140.

[2] This range assumes operation at a 65- to 70-percent capacity factor.

OBSTACLES TO ADOPTING COGENERATION SYSTEMS

Question 3. What obstacles to adopting cogeneration systems exist and how would the GAO recommend overcoming those obstacles?

Answer. Our report pointed out that development of cogeneration systems hinges a great deal on the attitude of utility companies. An industrial cogenerator might either have excessive capacity or it might require a back-up source of supply. In both cases, the cooperation of a utility and agreement on reasonable power exchange rates would be required. Neither are likely to be in the utility's best interests if electric utilities continue to have a large excess capacity in the near future. Several other factors contribute to a lack of industry interest:

Reluctance to generate electricity because of the capital intensity and relatively low rate of return.

Desire to avoid regulation by State and Federal Agencies.

Current electricity pricing policies which now provide industry the benefits of average cost pricing and in some cases, declining block rates.

Uncertainty regarding optimum equipment and fuel systems.

Uncertainty with regard to trained manpower for operations.

The need for added space for cogeneration facilities and the regulatory requirements that must be satisfied in constructing such new facilities.

Factors which contribute to a lack of utility interest include—

a reluctance to employ capital to serve a limited number of steam customers, and

unwillingness to purchase electrical power from sources which they do not own or control.

Most of the obstacles to adopting cogeneration systems result from an assumption of industry ownership. If cogeneration units are owned by utilities the prospects are much more favorable:

Cogeneration may be economically advantageous to utilities facing construction delays of an optimum size.

The regulated utility industry might undertake a cogeneration investment with a lower rate of return.

Electricity transmission and distribution cost are a major cost factor in cogeneration industry connections with utility grids used solely for contingent and/or periodic power. These are costly because of the low capacity factors. If power is exported to the utility the capacity factor can increase sharply, significantly reducing "standby" costs.

Although our report did not make specific recommendations to overcome obstacles to cogeneration, we did recommend that TVA undertake a major application/demonstration of cogeneration technologies which could lead to increased interest from the utility industry.

RESIDENTIAL CONSUMPTION TO DROP IN FUTURE

Question 4. The GAO report assumes that TVA electric rates may increase in the future in real terms. The report states, "Electricity consumption is sensitive to price changes. A 1 percent increase in the real price of electricity could lead to a 15.7 percent reduction in residential demand by the year 2000." I would like to point out that in the past 13–14 years, the residential price of electricity has increased more than 200 percent. Certainly, TVA rates have increased in real terms, taking inflation into account. So, if your statement is correct we would expect to find that residential consumption has decreased during this period. However, it is my information that in 1965 the average TVA residential customer used 10,381 kilowatt hours of electricity. Last year the average residential customer in the valley used 16,250 kilowatt hours, this is an increase of more than 60 percent during this period when rates have escalated so rapidly. So my question is this. How can the GAO say with certainty that if the real price of TVA electricity increases in the future, then demand will be reduced, when recent history indicates a different pattern?

Answer. We cannot say with certainty that if the real price of TVA electricity increases in the future, then demand will be reduced. Recent history does indicate, however, that electricity demand is falling not only at TVA but throughout the U.S. as electricity rates are increasing. What we are saying is that demand for electricity will be increasing, but not at levels as high as once projected. For example, TVA's demand projections a few years ago were reflecting 6 and 7 percent annual growth rates but are now reflecting 4 to 5 percent annual growth

rates. A recent article in the Wall Street Journal points out that, "Utilities around the country are finding that electric use is increasing at a much lower rate than anticipated." We are not saying that demand per household will decline but that demand is anticipated to increase, but not as great as once anticipated.

WRITTEN QUESTIONS FROM SENATOR SASSER TO TVA, AND THE RESPONSES

TVA DEBT CEILING

Question 1. What is TVA's present debt ceiling? When was it raised to this level? When the last increase was made, TVA indicated that it would last for five or six years, correct? Why has TVA had to come back to Congress early, if that is so?

Answer. The present TVA debt ceiling is $15 billion. It was increased by $10 million to the present level in November 1975, by P. L. No. 94–139. At that time TVA indicated that the increase would be sufficient for approximately five years. This is in keeping with the legislative intent of the 1959 self-financing amendment. The remaining balance of the $15 billion will not provide enough funds for projects already underway. Our request is, therefore, necessary to complete existing projects; and it is needed now because TVA cannot contract for any additional facilities since adequate financing authority is not in place to ensure their completion.

MULTIYEAR BUDGETING

Question 2. The Budget Committee—and the Federal Government as a whole, for that matter—is moving toward increased use of multiyear budgeting as a means of improving our control of Federal expenditures. Do you think TVA, as a part of the Federal budget, should be subject to the same discipline? In this regard, how long do you anticipate this $15 billion increase lasting? Do you anticipate having to increase that level in future years?

Answer. TVA is subject to such discipline. We use multiyear budgeting in the management of our power program. Because the construction of new generating facliities takes 10 to 12 years, the long-term nature of many of our contracts and the need to maintain stability in meeting our utility responsibility, it is imperative that we plan and budget on a multiyear basis.

On an outstanding obligations basis, the current ceiling will be exceeded in fiscal year 1981 and actual borrowings will reach the $15 billion level in fiscal year 1983. However, the ceiling is already limiting our ability to make decisions to begin the construction of additional generating capacity. We are requesting the increase in borrowing authority to permit TVA to make decisions and to start the new plants that will need to be started between now and 1985.

If the Tennessee Valley region continues to grow and demands for electricity continue to grow, TVA will need additional authority to borrow to finance the plants that will be needed beyond those provided for in our current request in about five years.

$15 BILLION DESIGNED TO COVER PROJECTED INFLATION

Question 3. What are you projecting inflation to be for the period this $15 billion is designed to cover? Have you allowed for inflation in this figure?

Answer. Yes; the anticipated escalation rate for construction of new generating facilites is 8 percent per year over the 1979–1995 time period. This reflects an overall inflation rate for the economy of between 5 and 6 percent during this time period as measured by the implicit GNP deflator.

DISTRIBUTION OF $15 BILLION FOR TVA PROJECTS

Question 4. What portion of this amount will be used to cover costs for ongoing projects? What portion of the amount will be allocated for new construction? Are you including the full costs of these projects in your planning, as TVA has done in the past?

Answer. About $4–$6 billion will be needed to cover the capital costs of all power program activities, including pollution control, transmission and conservation facilities, and the completion of the generating plants now under construction, depending on the extent of inflation.

The remainder of approximately $11 billion would be used for the construction of new generating facilities beyond the Yellow Creek plant. The full cost of completing these plants has been included in the $15 billion.

FINANCING $15 BILLION BORROWING AUTHORITY

Question 5. What source of financing do you anticipate using with the additional $15 billion in borrowing authority you are requesting? What is the current total in outstanding debt for TVA? How much of that is in short-term notes and how much in long term? What length of maturities do you anticipate assuming for future obligations?

Answer. The additional $15 billion authority requested will be issued in part to the Federal Financing Bank and in part directly to the bond market. The exact mix has not been determined and will be affected by a number of factors.

As of February 21, 1979, TVA's total outstanding debt was $7,785 million. Of this amount $1,760 million is short-term debt with original maturities of less than one year and $6,025 million is long term. Future issues will continue to be a mix of long- and short-term maturities but the basic debt of TVA will most likely continue to be its traditional 25-year bond.

INTEREST COSTS ON TVA INDEBTEDNESS

Question 6. How do you finance current interest costs of your outstanding debt? What will be the financial source for interest payments on your future borrowing?

Answer. Current interest expense on debt is financed from revenues from the sale of power. This is required by Section 15d of the TVA Act; consequently, it will apply to financing interest payments on future debt.

FINANCIAL RISK OF NUCLEAR CONSTRUCTION

Question 7. The Federal Financing Bank does not alter its interest terms according to different uses of its funding. Do you think there is a higher financial risk involved in borrowing for the construction of nuclear power facilities over conventional facilities? Would you say there are higher "front-end" costs associated with nuclear power facilities, and if so, can you describe them? Would you say there is a longer lag-time for nuclear facilities from the time of initial investment and the eventual benefits? If so, is there a higher interest cost involved and how much?

Answer. There are certainly financial risks associated with construction of nuclear facilities, but it is very difficult to state clearly that such risks exceed those associated with other types of generating facilities. For example, it would have been very difficult to have foreseen the risk associated with ownership of oil-fired facilities prior to the oil embargo. There are also uncertainties related to environmental effects of coal-fired plants.

Our engineers, as well as a number of national engineering firms who are knowledgeable in the area of construction costs of electric power plants, generally state that fully equipped conventional coal-fired facilities cost about 20 percent less than similar nuclear facilities. These higher front-end costs primarily reflect longer lead times, but they do mean that interest costs are higher for nuclear plants than for conventional coal-fired plants over the life of the plants. There is a generally accepted view that nuclear lead times are about two years longer than conventional coal-fired plants from point of initial investment to commercial operation. These costs are offset by the lower cost of nuclear fuel.

Primarily because of the longer lead times, the amount of interest paid during the period of construction is substantially higher for a nuclear plant than for a coal-fired plant. Interest during construction may account for 30 percent of the total construction cost of a nuclear plant compared with 15 percent of a coal-fired plant.

Thus, interest costs associated with a nuclear plant are considerably higher during the periods of both construction and operation.

VARIANCE OF CAPACITY COST

Question 8. How much does 1,000 megawatts of capacity cost in today's dollars? How much do you expect that cost to increase in the next 5 to 10 years?

Answer. Capacity costs vary significantly depending on the technology used for generation. For example, in today's dollars a nuclear generating plant might

run about $800 per kw while a fully equipped conventional coal fired plant might run about $700 per kW. For a mix of generating plant types such as might be put in place over a period of years, the estimated cost of 1,000 megawatts of capacity might average about $750 million in terms of today's dollars. Based on an escalation rate of 8 percent per year, we would expect to pay about $1.6 billion for 1,000 megawatts of capacity for plants committed by 1985.

COST OF NUCLEAR PLANTS UNDER CONSTRUCTION

Question 9. Tell us again, what are the remaining costs of your nuclear power plants under construction and on order?

Answer. Based on current cost estimates, the remaining cost to complete our nuclear power plants under construction, calculated on an obligations basis, was about $6.4 billion at the end of fiscal year 1978. However, I am afraid that with continuing inflation, that figure may go $1–$2 billion higher.

COST OVERRUNS IN TVA CONSTRUCTION PROGRAM

Question 10. The GAO testified this morning that they have recently been studying cost overruns in TVA's construction program. They have indicated that remaining costs total $11.8 billion. Why do you and GAO have such different estimates?

Answer. We have conferred with GAO and apparently the $11.8 billion represents the total cost of TVA's nuclear plants under construction—not the remaining costs to complete these projects. TVA's current estimate of the total cost of all of its nuclear plants presently under construction is $11.895 billion which is in close agreement with GAO's estimate of the total cost of these projects. However, we are afraid that both estimates do not take sufficient account of inflation that may persist.

RECOMMENDATIONS FOR SAVINGS IN TVA CONSTRUCTION

Question 11. Recently a private consulting firm reported to the TVA that TVA could save $200 million in future capital investment of nuclear power plant construction. Please outline the recommendations that were made and tell us how TVA plans to implement them.

Answer. TVA hired the management consultant firm of Theodore Barry and Associates to perform a management performance review of the Office of Engineering Design and Construction.

There are 115 recommendations contained in their report. The recommendation with the greatest potential saving is improvement in utilization of the construction work force. We have already implemented this recommendation at our Hartsville project through a contract with Theodore Barry, and will expand this program to other projects as quickly as possible. Other significant recommendations were centered on improvement in project control, financial management, procurement, organization, and support services. Each of the recommendations has been assigned to a line or staff manager who is responsible for developing an action plan including a timetable and an evaluation of resources required and benefits expected for each item. Many of these recommendations were already begun prior to the completion of the report. We believe significant savings can be achieved but no specific estimate has been made by Theodore Barry or TVA.

ALTERNATIVE LOAD FORECASTS

Question 12. The GAO report states that TVA's past planning has been almost entirely dependent on a single demand forecast for a 15-year period. You have stated that you agree with this criticism that a range of estimates is more appropriate. Further you state that TVA no longer has a single estimate of future demand.

If you are no longer using a single demand forecast, when did you change this practice, before or after you had received word that the GAO report was going to be critical of your earlier projections?

The GAO report recommends that TVA create a comprehensive, long-range power program plan extending for at least 25 years. Previously, TVA's single demand forecast has been for only 15 years. Do other utilities utilize 15-year or 25-year forecasts? Since you have stated that you no longer have a single estimate

of future needs, can I assume you have lengthened the range of your forecast from 15 to 25 years?

Answer. TVA began developing ranges of estimates before the GAO review. However, the first official use of alternative load forecasts was in the July 1978 forecast after GAO had reviewed TVA's forecasting procedures.

Other utilities prepare forecasts which range anywhere from 10 to 25 years. TVA's July 1978 load forecasts and TVA's February 1979 load forecasts have been prepared in detail to the year 2000.

LONG-TERM FORECAST USED IN DETERMINING BORROWING AUTHORITY

Question 13. When the TVA requested the Administration to recommend an additional $15 billion in borrowing authority, did you make your assumption based on a single short-term forecast or based on a more comprehensive long-term forecast?

Answer. TVA used a set of long-term comprehensive forecasts extending to the year 2000 in determining the appropriate increase in borrowing authority.

BROADER PUBLIC INPUT IN TVA DECISIONMAKING

Question 14. At this point in the record, I would like to insert a copy of TVA's news release announcing the request for an increase in the bond ceiling.

Chairman Freeman, you have advocated, as Chairman of the TVA Board, broader public input to TVA decisionmaking. You have held a number of public meetings throughout the Valley and I understand that more are planned. I commend you for that effort. I think TVA should continue to seek public opinion.

However, it is my understanding that the decision to seek a $15 billion increase in bond authority was made without seeking the advice of the TVA consuming public. Why did TVA fail to seek input from its customers in this instance?

Answer. The increase in TVA's debt ceiling was submitted to OMB as a part of TVA's legislative proposals for consideration by the President as a part of his fiscal year 1980 program. Public disclosure of proposals of this nature have historically been considered privileged until the President submits his program to the Congress. Consequently, public discussion of the proposed increase was inappropriate. The public hearings on the bond ceiling request are being held by the Congress, which is the decisionmaking body.

As you point out, TVA has held a number of public meetings throughout the Valley. The number of meetings and the breadth of the subject matter is revealed in the following tabulation of TVA's public participation events since January 1, 1978.

As the tabulation suggests, TVA is making every effort to obtain customer input on specific decisions and will continue this practice as decisions are made in the future.

Subject and date	*Location*
Decision by TVA not to approve plans for two small bridges across embayment on Nickjack Dam: Jan. 30, 1979.	Chattanooga, Tenn.
Uranium:	
Jan. 25, 1978	Crownpoint, N. Mex.
July 25, 1978	Crownpoint, N. Mex.
Transmission lines:	
Jan. 9, 1978	Chattanooga, Tenn.
Mar. 7, 1978	Guntown, Miss.
Apr. 11, 1978	Russelville, Ala.
Apr. 13, 1978	New Albany, Miss.
Apr. 14, 1978	Somerville, Tenn.
June 12, 1978	Hopkinsville, Ky.; Cadiz, Ky.
July 31, 1978	Gallatin, Tenn.
Sept. 25, 1978	Elizabethton, Tenn.
Oct. 16, 1978	Clarksville, Tenn.
Oct. 17, 1978	Springfield, Tenn.; Gallatin, Tenn.
Nov. 30, 1978	Jamestown, Tenn.
Feb. 6, 1979	Church Hill, Tenn.

Subject and date	*Location*
Rates:	
Aug. 28, 1978	Knoxville, Nashville, Memphis, Chattanooga, Tenn.; Paducah, Ky.; Tupelo, Miss.; Huntsville, Ala.
Nov. 21, 1978	Knoxville, Nashville, and Memphis, Tenn.; Bowling Green, Ky.; Tupelo, Miss.; Florence, Ala.
Feb. 20, 1979	Knoxville, Nashville, and Memphis, Tenn.; Paducah, Ky.; Tupelo, Miss., Huntsville, Ala.
Ocoee No. 2: Rehabilitation project—Oct. 12, 1978.	Cleveland, Tenn.

Additional public meetings already scheduled for 1979

Subject and date	*Location*
Uranium: Mar. 1, 1979	Edgemont, S. Dak.
Chattanooga office complex: Late March	Chattanooga, Tenn.
Service practice standards:	
Mar. 1, 1979	Memphis, Tenn.
Mar. 6, 1979	Nashville, Tenn.
Mar. 8, 1979	Huntsville, Ala.
Mar. 13, 1979	Knoxville, Tenn.
Mar. 15, 1979	Chattanooga, Tenn.
Mar. 20, 1979	Paducah, Ky.
Mar. 22, 1979	Tupelo, Miss.

POLICY REVIEW PROGRAM

TVA recently involved a wide range of citizens in the agency's long-range planning process. TVA asked Tennessee Valley consumer organizations to recommend citizens to meet with TVA representatives in late October 1978 to discuss issues relating to energy and regional developmnt. Approximatly 200 citizens participated in 36 meetings. The information from these meetings has been analyzed and will be presented to the TVA Board in the near future.

TVA'S CONSERVATION PROGRAM

Question 15. In TVA's letter to the Governmental Affairs Committee you discussed TVA's conservation program at length. The letter states, "We expect these TVA conservation programs will be productive in promoting conservation and in reducing demand."

The GAO report said that if the TVA were to implement the three residential programs proposed in the National Energy Act and the heat pump program, the combined program would produce a net total savings to the region's households of about $190 million. The GAO also estimates that implementing the National Energy Act residential program along with the heat pump program would reduce demand. If they were fully implemented the demand is estimated to be reduced 12–16 billion kilowatts by the year 1990. Does the TVA agree with this assessment and why?

Answer. The GAO's high and low projections are 12–16 billion kilowatthours lower than the July 1977 TVA forecast for 1990 when the residential programs proposed in the National Energy Act and the heat pump program are considered. The report indicates that between 3.5 and 4.7 billion kilowatthours of this difference are directly attributable to these programs. The $190 million is the present value of net benefits discounted at 8 percent per year.

On pages 5–6 of their report, GAO also indicates that implementation of the three residential programs proposed in the National Energy Act and the heat pump program would result in a reduction in electricity consumption ranging from 3.6 to 6.4 billion kilowatthours by the year 2000. TVA's analysis indicates

that the implementation of these programs would reduce demand by 7 to 9 billion kilowatthours by that time. Even at present rates, this would result in a reduction in the electric bills of residential consumers of between $210 million and $270 million per year when the programs are fully implemented. Net savings would be somewhat less than this since it would reflect costs of program implementation incurred by TVA or borne directly by the consumer. We have not tried to verify the GAO estimate of present value, but we do not disagree that these programs will yield substantial benefits to consumers.

TVA'S INTERCHANGE AGREEMENTS

Question 16. The GAO report points out that the TVA power system is a winter peaking system. Currently TVA has several interchange agreements with various utility companies whose peaks occur in the summer months. Currently this total interchange power of 2,050 megawatts is considered by the TVA to be firm generating capacity during the winter months.

However, GAO points out that some of these interchange agreements are being reduced. Please tell us why these agreements are being changed and the effect this reduction will have on the TVA power system.

Answer. TVA's present level of seasonal interchange is 2,060 megawatts. This seasonal interchange will be reduced to 1,580 megawatts in November 1979 and further reduced to 1,100 megawatts in November 1980. When these contracts were entered into, it was anticipated that the load served by TVA would continue to peak in the winter even with the seasonal exchange. This has not happened. The actual load levels that TVA has had to serve with this high level of interchange have included summer and winter peaks of approximately the same magnitude.

The decrease in the level of interchange should improve the reliability of our generating system by allowing maintenance and nuclear refueling to be performed during the summer periods as well as the spring and fall periods. As the system grows, there is not enough margin for maintenance during the spring and fall periods to adequately perform the maintenance requirements. Thus, it has been necessary to reduce the interchange level in order to gain additional time for maintenance.

COGENERATION SYSTEMS IN TVA AREA

Question 17. TVA has recently completed an extensive study of cogeneration potential in the Valley. GAO has estimated that potential to be 5,200 to 6,700 megawatts by the year 2000.

Fifty years ago, 30 percent of all U.S. electricity generated at industrial sites was produced through cogeneration. Today that number is only 4 percent. I believe we must make greater use of this technology. There are certain barriers to its development, however. The cooperation of a utility and agreement on reasonable power exchange rates would be required. And there is the question: Who will own the cogeneration system—TVA or the industry? How does TVA propose to deal with these barriers?

Answer. TVA has a task force working on the development of cogeneration in the TVA region. A preliminary assessment of the cogeneration potential is in the final draft stage. As a part of this effort, we have reviewed the barriers to cogeneration development in the TVA region so that we can develop appropriate methods for overcoming these barriers. The task force's recommendations to the TVA Board of Directors will address the following area: the establishment of appropriate rates for electric power sold by a cogenerator to the TVA grid; the appropriateness of rates applied to the cogenerator's power purchases; provision of technical assistance for the final design of interconnections with the TVA grid, development of operating procedures, and the exchange of operation and maintenance information; and guidelines for ownership and financing arrangements. There are practical problems related to TVA owership of equipment located in industrial plants owned by private concers. It is possible that TVA and the cogenerator could enter into an agreement for a third party to own the cogeneration facilities at an industrial plant. TVA could also provide direct financial assistance to prospective cogenerators.

The TVA Board intends to develop a specific policy statement to encourage cogeneration in the near future. We will also continue our work in the development of cogeneration potentials in existing generating plants, building cogeneration into energy parks, a central coal-fired cogenerating plant, and the use of other emerging technologies with cogeneration possibilities.

TVA'S FLUIDIZED COMBUSTION RESEARCH

Question 18. Since coming to the Senate I have supported additional funds for TVA's fluidized-bed combustion research. Presently TVA is working on both pilot scale and demonstration scale projects. Please give us a status report on these projects. Tell us what you see to be the potential of the fluidized bed in the TVA system.

Answer. The pilot plant is in direct support of our demonstration plant effort. A request for proposals is being prepared for release to the boiler manufacturers for the pilot plant on April 15, 1979, and the scheduled operation date is June 1982. Other projects in support of the demonstration plant are the Oak Ridge National Laboratory studies and a cofunded effort with the Elecric Power Research Insitute for corrosion studies in AFBC units.

The 200-MW atmospheric fluidized-bed combustion (AFBC) demonstration plant program is being continued with a final design study by several boiler manufacturers slated to begin in April 1979, and is scheduled for startup in January 1985.

Fluidized-bed combustion has the potential for being operational in the TVA system by the early 1990's. Using the valuable data from the demonstration and pilot plants, we are confident that a commercial AFBC plant can be built during this time period which is lower in cost, higher in efficiency, and more reliable than a conventional coal-fired plant with scrubbers. Such fluidized-bed plants could utilize the lower cost, high-sulfur coals prevalent in the Tennessee Valley, western Kentucky, and southern Illinois. This could reduce TVA's dependence on the high cost, low-sulfur coals which are being utilized in the older existing plants.

LONGWALL MINING

Question 19. The GAO report recommends that TVA do more to encourage the longwall mining technique of extracting coal from underground mines. TVA has indicated that in many cases longwall mining is not the best or even a feasible technique for mining operators. Please discuss that statement for the record.

Answer. The longwall mining method gives better labor productivity and generally gives improved recovery when it is successfully applied; however, it has many drawbacks which limit its application. It is an inflexible system. For example, it can be used only on large continuous areas of coal unbroken by faults or nondeposition and free of oil and gas wells. The seam must also be of uniform thickness since the cutting equipment cannot adapt to changes in floor or roof elevation without adding extraneous material or leaving good coal behind. If either floor or roof is too soft, the support system will become inoperative or the operation will be hazardous.

A 2-unit longwall mine, the minimum practical size, should produce from 1.0 to 1.5 million tons of coal per year. To repay the capital investment, a life of 10 years or more would be needed. As a consequence, the mine would require a minimum recoverable coal reserve of 10 to 15 million tons. Few coal deposits of this size meeting the other physical requirements are available.

Another factor that must be considered is the surface subsidence. While the surface can be preserved by conventional mining, subsidence cannot be avoided when longwalling. This fact prevents the longwall method from being used in areas where surface integrity must be maintained.

MORE INTERRUPTIBLE CONTRACTS PLANNED BY TVA

Question 20. The GAO report recommends that TVA expand the use of interruptible contracts offered on a regular basis rather than an emergency basis. I know that TVA is now considering such a proposal. Please tell us what you are planning and the effect the change could have on future demand.

Answer. TVA has 749,500 kW of interruptible power under contract with 13 directly served customers. Generally, the contracts provide for reducing TVA's system peaks by TVA's giving five minutes' notice to suspend delivery of power. It may be interrupted up to 12 hours a day, 48 hours a week, 600 hours a year, with an overall maximum of 3 percent of the time over a 10-year contract term. Three older contracts are subject to shorter periodic interruptions and can be interrupted either 2 or 2.5 percent of the time.

Three-percent interruptible power is sold at a discount of 7.1 percent from the current firm rate, while the discount for the older 2- and 2.5-percent interruptible power is only about 1.3 and 2.6 percent, respectively.

On February 16, 1979, the TVA Board approved new rates and terms for 5-percent interruptible power that may be made available in amounts of 5,000 kW or larger to any distributor served or directly served industrial customer in conjunction with firm power. TVA's interruptions would be limited to 5 percent of the total hours in a contract term, 800 hours in any 12 consecutive months, 60 hours in any week, and 12 hours in a day. Delivery of power may be suspended by TVA on five minutes' notice. For these curtailments, the industry would receive a monthly billing credit of up to about 13 percent from the current firm rate.

With these new interruptible terms now available, the prospective market for interruptible power is estimated to increase to over 1,000,000 kW of interruptible power under contract in 10 years. Industrial customers not presently purchasing interruptible power will be given an opportunity to convert part of their firm power requirements to the new 5-percent interruptible power. Negotiations are curently underway with four directly served customers to convert 347,000 kW of 3-percent interruptible power presently under contract to the new 5-percent interruptible power terms.

TVA also continues to explore with its customers other possible interruptible power arrangements that might prove technologically and economically feasible for the customer and TVA.

STATEMENT OF TENNESSEE VALLEY INTER-LEAGUE COUNCIL, LEAGUE OF WOMEN VOTERS, NASHVILLE, TENN.

(The Tennessee Valley Inter-League Council (TVILC) is a group of all the local and state Leagues of Women Voters within the Tennessee Valley Authority's service area.)

IMPROVED COST CONTROL IMPACT ON TVA BUDGET

Recently, Theodore Barry & Associates, a private consulting firm, did a management performance review of the Office of Engineering Design and Construction (OEDC). Though the OEDC is but one office within TVA, its 1.5 billion dollar annual expenditures qualifies it as a major cost center. The potential for improved cost control in the OEDC would have significant impact on the TVA budget. Some of the findings of the Barry report are:

(1) The present TVA budget does not adequately reflect the traditional role of the budget as a managerial control tool. It's not a control tool because short and long term funds have been easily accessible to the TVA through the U.S. Treasury and the Federal Financing Bank. With such easy access to money there is little motivation to keep cost down. This is probably best reflected by the following suggestion that the Barry report makes to the TVA, that is, "The dollar should be viewed as a scarce resource and should be managed on a fiscal year basis." It seems incredible that the TVA has to be reminded that money is a scarce resource.

EXPENDITURE ESTIMATES VARY FROM ACTUAL EXPENDITURES

(2) The OEDC expenditure estimates often vary significantly from actual expenditures. In 1977 the cash flow expenditures developed by the Financial Planning Officer were calculated to be 1.6 billion dollars. In a special, one-time study, the Division of Finance calculated actual cash expenditures to be about 3 billion dollars—almost double.

In its last 8 construction projects OEDC's original estimates have been off by 5 billion, 746 million dollars. Six of these projects are not yet complete and the Barry report comments that there is a "trend toward identifying larger and larger cost increases as each project moves toward completion." The question that comes to mind is how much more will these projects overrun their estimates?

Estimating is a TVA-wide problem not confined to OEDC; but OEDC's history of fluctuating expenditure estimates seriously impacts the credibility of any TVA financial plan.

(3) For OEDC to make significant strides in its budget program, improved authority, accountability and responsibility must be established. OEDC cannot readily identify the manager specifically responsible for cost and schedule performance variances, since responsibility is widely spread through the branches of TVA. The lack of a more explicit accountability obscures responsibility, pro-

motes finger-pointing, protects poor managers and limits the effectiveness of good managers.

TVA IGNORES CONSULTING FIRMS STUDIES

These were but a few of the hundreds of other suggestions made by the Barry report. As citzens who are painfully aware that cost overruns and higher interest payments result in higher rates, it should give us pauses to think that TVA is now asking for a doubling of their loan ceiling. Some of the questions that come to mind are:

(1) Could this request of a 30 billion dollar loan ceiling be postponed until there is evidence that the TVA is actively working on the suggestions of the Barry report? The GAO report points out that the TVA in just the past decade had three other consulting firms do studies that the TVA ignored. If there was an economic incentive tied to TVA's accountability in this area, there might be a better response.

(2) Why does there have to be a doubling of the loan ceiling? If, indeed it is proven that TVA needs additional money, a much lower rise in the ceiling would force a more frequent review of TVA's financial state. If money was not as easily accessible to the TVA it would have to tighten controls as a matter of necessity.

For 59 years the League of Women Voters has advocated efficient and accountable government. We would like to thank Senator Sasser for giving us this opportunity to express our concerns in this matter. Thank you.

TELEGRAM FROM THE ELECTRIC POWER BOARD OF NASHVILLE

Nashville, Tenn.

Senator JIM SASSER,
Post Office Building,
Knoxville, Tenn.

The Electric Power Board of Nashville endorses the proposal Congress boost TVA debt ceiling from 15 billion to 30 billion. Funds needed to complete construction of new energy generating plants should stabilize price of electrical energy to consumers in the TVA area.

J. DUDLEY PHILLIPS,
Chairman Electric Power Board.
PAUL P. HEMBREE,
General Manager.

TENNESSEE VALLEY AUTHORITY,
Knoxville, Tenn., January 31, 1979.

Hon. JACK BROOKS,
Chairman, Committee on Government Operations, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: We are making this written statement on actions taken by TVA on the recommendations to TVA contained in the General Accounting Office's (GAO) report issued on November 29, 1978, entitled "Electric Energy Options Hold Great Promise for the Tennessee Valley Authority." This statement is made pursuant to section 236 of the Legislative Reorganization Act of 1970 (31 U.S.C. § 1176 (1976)).

The report contains analyses of some of the issues facing TVA. However, because GAO's investigations were conducted in 1977, the report does not reflect many more recent TVA programs and policies. As further described below, TVA is now actively engaged in the implementation and consideration of essentially all of the report's suggested actions, as well as significant other programs not discussed by GAO. In large measure the report mirrors TVA's efforts, and, thus we do not view this report as inconsistent with TVA's current programs in this area.

The report recommends energy conservation, improved power management, and the use of renewable resources. TVA agrees with the point being made by GAO that there are great potential benefits which may be achieved by these programs. TVA commenced work in all of these areas long before the GAO views were expressed. We no longer have a single estimate of future needs—the primary fault GAO finds with our estimates. We agree that a range of estimates is more appropriate. System planning must be based on analysis of the potential maximum, as well as minimum, demands. As demonstrated by the substantially differing projections by various organizations and individuals

considering such matters, there are substantial uncertainties in any long-term forecast of electricity consumption. Accuracy within 15 percent on a 10-year forecast is considered unusual. Even a few percent difference in peak load in the 1990's equates to a 1,000–MW generating unit. The GAO load forecast failed to take into account transmission losses, outdoor lighting, and interdivisional electricity sales within TVA. Thus, if these elements had been taken into account, GAO's lowest load forecast would have found that TVA needed 4,000–5,000 MW of added generating capacity in this century.

The economic growth in this region will continue to be significatly greater than that of the Nation as a whole. We currently project that in the next decade the gross product of our region will increase on the order of one-third faster than the Nation's and this will inevitably result in substantial additional requirements for electrical energy. Such growth, combined with the inherent uncertainties in long-range forecasting, requires that TVA retain flexibility to adjust its construction program as new data are obtained. TVA is undertaking many projects to encourage energy conservation, improve load management, and stimulate use of renewable resources. We expect these programs to succeed and we fully take them into account in our forecasting. However, there is a 10- to 12-year lead time for building new generating capacity and this, too, must be taken into account in system planning. In light of these long lead times, the TVA Board, in carrying out its responsibilities, must be careful not to tie the region's future to what may turn out to be an overly optimistic forecast.

The action being taken with respect to the recommendations to TVA is discussed below.

1. *Recommendation.*—TVA [should] prepare a long-range comprehensive plan (minimum of 25 years) with specific short-term goals to be presented to the President and the Congress. This plan should be updated and submitted annually. TVA should obtain review of the draft plan from a wide spectrum of the regional population. The Department of Energy should review the plan to ensure that it reflects national priorities and does not duplicate research and development projects and TVA should include their comments as an appendix with an evaluation of those comments. GAO should evaluate the final plan, monitor its progress, and report to the President and the Congress periodically. The Congress would then be in a better position to plan any needed hearings.

Response.—This is a good idea which TVA was already in the process of implementing. To improve the planning process, the TVA Office of Power has established a strategic planning staff to formulate and document long-range plans for the power program. This staff is now preparing a comprehensive long-range plan for the power program, and TVA will solicit comments on that plan from the public and state and Federal agencies, including GAO and DOE.

2. *Recommendation.*—TVA should prepare several 25-year electricity demand projections emphasizing energy conservation and the use of renewable resources.

Response.—As we earlier informed GAO representatives, TVA's system of annual demand forecasts now includes numerous projections, representing a range of economic growth possibilities, potential new technologies, energy conservation efforts, and trends toward substitution of electricity for scarce fossil fuels. Such a range was included in TVA's July 1978 forecasts and will be expanded in future forecasts. These projections of use of electricity to the year 2020 allow the TVA Board and staff to consider the range of uncertainties in planning the future of the power system.

3. *Recommendation.*—TVA should collect more detailed information on all users and uses of electricity. For example, TVA should survey residential customers to determine patterns of ownership for major household equipment, appliances, and housing units and meter individual appliances in homes throughout the region.

Response.—TVA has underway a number of studies on electricity end use and additional studies are being planned. These studies involve the installation of special equipment for metering the electricity use patterns of thousands of consumers and are providing the basic data necessary to consider the appropriateness of possible new rate designs and make judgments on the feasibility of new equipment. In addition to more traditional patterns of use, the studies will investigate the effects on use of (1) time-of-day rates, (2) radio-controlled water heaters, electric space heaters and air-conditioners, (3) $uper $aver homes, (4) special heat pump-heating-cooling storage device tests, and (5) elec-

tric furnaces with special brick storage units. In one such study the timing and amount of residential hot water use is metered.

4. *Recommendation.*—TVA should undertake a major application/demonstration of cogeneration technologies which could include:

A coal-fired steam turbine system in the several tens of megawatt range.

A gas turbine system in the 50–200 megawatts range capable of using alternative fuels (for example No. 6 oil, methanol, residual fuel oil, etc.) in a cogeneration mode.

A fluidized bed gas turbine system coal fired, coordinating its effort with the work of American Electric Power Company. In that company's system, steam from the gas turbine is run through a steam turbine to produce additional electricity. However, the TVA demonstration should be of a size to demonstrate the capacity of feeding excess generation to the network and simultaneously producing process steam for industry.

A fluidized bed gas turbine system fired by biomass, in particular, wood waste. This demonstration could be located at a major wood and paper products complex such as the one in Calhoun, Tennessee. It would show fuel cycles and alternatives to coal and concentrate on industrial and agricultural wastes and perhaps municipal waste.

Federal funding should be requested for those demonstrations that exceed TVA's incremental cost per kilowatt.

TVA should continuously assess the potential for new industry cogeneration projects and support industries with such potential, particularly those in newly developed industrial parks.

Response.—Cogeneration is receiving a great deal of attention from TVA. We are working actively with industry and public agencies to develop cogeneration projects and are conducting a number of studies of cogeneration opportunities. TVA has recently completed an extensive study of cogeneration potential in the TVA area, and a detailed report on this assessment will be published in the near future. A program plan to maximize the installation of cogenerating facilities in this area is under development. This program is expected to include the demonstration of various arrangements, technologies, and fuels, including some of those mentioned by GAO. As noted in the GAO report, initial installation of some promising approaches may not be economical at this time. Accordingly, we agree with GAO that appropriations should be used to assist these demonstrations.

One area of cogeneration potential being planned by TVA but not mentioned by GAO is the utilization of waste heat from steam electric power plants. TVA has examined a number of potential uses for this waste heat, including aquaculture and greenhouse applications. TVA is actively working with Rhea County, Tennessee, on plans for an industrial park designed to utilize the waste heat from TVA's Watts Bar Nuclear Plant. In addition, TVA recently, in cooperation with the Electric Power Research Institute, conducted a national workshop on waste heat utilization to promote use of this resource now being wasted.

5. *Recommendation.*—In complying with the proposed consent decrees, TVA should follow the maximum demonstration and development of flue gas desulfurization technologies in its coal-fired units, as proposed in chapter 6. Such a program would cost more than simple compliance would require and would entail certain risk. We recommend, therefore, that TVA request an appropriation for this program for those costs over and above simple compliance.

Response.—TVA's sulfur dioxide program is constrained by the requirement that compliance with state and Federal air quality standards be achieved as rapidly as possible. However, TVA has not sacrificed the research and development opportunities this massive control program offers. The flue gas desulfurization equipment TVA is installing will employ a variety of designs, including advanced technology systems, and will significantly advance scrubber development. At our Paradise and Widows Creek plants we will be installing limestone scrubbers which will provide TVA an opportunity to continue its research in methods of achieving greater removal efficiency from this type of equipment and also to develop solutions to the problem of long-term sludge disposal. On the Johnsonville plant we are installing an advanced magnesium oxide scrubbing system which will produce sulfuric acid, a useful byproduct, instead of sludge. At Cumberland we are hoping to be able to use an advanced scrubbing system, utilizing an entirely new technology; however, these plans will be dependent upon the approval of a suitable schedule by EPA and the other plaintiffs in the litigation. We believe this mix of scrubber systems will provide all of the research and development benefits that the report recommends. GAO recommended that appropriated funds

be used to cover any additional cost of TVA's utilizing advanced rather than conventional scrubbing systems. We agree with this recommendation since such improvements would benefit the Nation as a whole.

6. *Recommendation.*—TVA should construct commercial scale atmospheric fluoridized bed combustion. Because of the risks inherent in this unproven technology, we recommend that this demonstration be funded the same as the cogeneration technologies above. Upon successful demonstration of this fluidized bed combustion, we recommend that it be used to meet all major TVA power production facilities required through the year 2000.

Response.—TVA is taking the lead in demonstrating this technology, working on both pilot plant scale and demonstration plant scale projects. If these projects are successful, a commercial scale facility should follow. We agree that this important research and development effort should be carried out with appropriated funds, and we have obtained both appropriations to TVA and DOE funding for the preliminary work on these projects. Because this is an R & D project that will benefit the Nation, we believe Federal funding should comprise a substantial portion of the capital and operating cost. Moreover, since it would not be appropriate for the ratepayers of this region to bear such costs, we believe the Federal Government should assume the risk of the commercial scale project. Upon successful demonstration of the commercial scale facility, it will be possible to determine how AFBC should fit into TVA's future power supply plans.

7. *Recommendation.*—TVA's future coal purchasing policies should include actively pursuing contracts with coal mine operators who are using longwall mining techniques.

Response.—TVA currently has contracts with four coal companies that utilize longwall mining, and a fifth company will probably add a longwall machine in the near future. However, in many cases longwall mining is not the best nor even a feasible technique for mining operations.

8. *Recommendation.*—Although TVA has recently expanded its conservation and demand management programs, it should extend or undertake the following options:

Increase efforts to implement the National Energy Plan programs.

In conjunction with the education and certification of heat pump installation and maintenance, actively encourage installation of heat pumps in all new construction.

Study and implement seasonal and time-of-day rates.

Expand the use of interruptible contracts, but offer them on a regular interruption basis rather than an emergency.

Initiate a program to switch off hot water heaters and larger air conditioners in peak hours.

Evaluate and pursue opportunities for matching variable loads in the region.

Response.—TVA is out front in the implementation of the national energy goals. Existing TVA programs, particularly the Home Insulation Program, have already been expanded and include many features of the National Energy Conservation Policy Act (NECPA). The Home Insulation Program includes free energy audits and no-interest loans for home insulation and other types of weatherization measures.

TVA's existing $uper $aver Electric Home Program encourages energy efficient home construction and the use of heat pumps. Public hearings on service *practice* standards have been officially announced by TVA under the Public Utility Regulatory Policy Act (PURPA). In addition to the five mandatory PURPA standards, four other standards will be considered, including energy-efficient standards for new buildings as a condition of service. With or without mandatory weatherization standards, TVA will accelerate efforts to encourage the use of heat pumps in new homes. The existing Home Insulation Program now includes low-interest, long-term financing for heat pumps in existing homes. The use of electric heat pumps is also being encouraged through TVA's Certified Electric Heat Pump Installation Program, which is an attempt to encourage heat pump acceptance by fostering proper installation and service.

TVA will also be conducting proceedings pursuant to PURPA and NEPA to consider the ratemaking standards defined by PURPA. Time-of-use rates are included in those standards. Such rates may be cost effective only for large commercial and industrial customers. Seasonal rates will also be examined as part of TVA's overall rate study currently underway.

TVA's use of interruption rights under contracts providing for interruptible rights is not limited to emergency situations as indicated by the GAO report. In fact, such rights can be exercised at such times as TVA considers will be bene-

ficial, provided such reductions do not exceed the amount specified in the contract. TVA is presently considering a proposal where interruptible power arrangements would be available to a much larger number of customers and would provide for additional interruption rights under the individual contracts. It is anticipated that the proposed new arrangements would result in increasing total interruptible load under contract from 750 MW to 1,150 MW over the next ten years.

A program is underway in four locations in the TVA area—Huntsville, Alabama; Jackson, Tennessee; Cleveland, Tennessee; and Tri-County EMC, Tennessee and Kentucky—to determine the effectiveness of cycling water heaters, electric space heating, and central air-conditioners during hours of peak demand. The purpose of this test is to evaulate the customer's reaction to this equipment and the cost and benefits to TVA, the distributor, and the customer, and to determine the operating procedure in installing such equipment by the distributor and subcontractor.

To the fullest extent feasible, we will include the possibility of matching variable loads in the region as part of our load management program.

9. *Recommendation.*—To further decrease electricity demand, TVA should:

Promote the use of solar passive building design with incentives such as design awards for builders similar to the heat pump and Super Saver home programs.

Design a strategy similar to the above promotion for solar water heating. In addition, TVA should provide alternatives for making these systems economically competitive for the consumer (such as reduced rates) since they are less costly to the power system than adding new generation capacity.

In coordination with the Department of Energy, participate in the research and development of solar space heating and cooling for applications in the region.

If the above options and other TVA initiatives do not adequately reduce demand, TVA should consider applying a surcharge or issue bonds that would result in similar impacts to effect additional conservation savings. Money received should then be used as an incentive to further conservation and the use of renewable resources.

Response.—TVA is undertaking a major program to promote the widespread use of solar passive buildings in this region. For example, TVA arranged for the construction of ten solar passive homes to be completed this spring. Under provisions of contracts with builders, TVA will pay $2,500 toward the cost of each of the ten homes built to solar passive designs developed by TVA architects. These homes will be instrumented to gather data on building design performance, and detailed construction costs will be made available to TVA.

Cost and building performance data from these ten homes and results of modeling studies currently in progress to determine the benefits to the power system resulting from solar passive homes will be examined prior to establishing incentives for about 200 additional demonstration homes built to several TVA solar passive designs. This second phase is expected to help overcome builder/buyer/lender resistance and provide considerable solar passive visibility throughout this region.

TVA redesigned the Lakeland Wesley Village, a proposed 96-unit housing project for the elderly, for solar passive space conditioning. Solar designs are under joint study by the sponsoring organization and TVA to consider the amount of financial assistance TVA could possibly provide to help defray the higher first cost associated with the solar design. TVA regards this project as a much-needed demonstration of solar passive design suitable for retirement villages, dormitories, motels, hospitals, and similar buildings.

Standards for solar passive buildings are also expected to be an important issue during the hearings and decision process on service practice standards pursuant to PURPA. As the TVA solar program progresses, consideration will be given to the use of design award incentives and other incentives to promote solar passive buildings.

The strong TVA commitment to solar energy calls for the prompt use of all means available to develop cost-effective solar applications in this design.

The importance of solar water heaters as alternatives to new generating capacity and the consumption of depletable energy forms is fully recognized by TVA. Strenuous efforts to make solar water heaters economically competitive in this region are being made. TVA has underway a project to install 1,000 solar water heaters in Memphis. This project is expected to demonstrate that the public is ready to buy and use solar water heating now. The problem of high first cost is

overcome by an easy monthly payment plan (as part of the electric bill) along with low interest rates. The experience gained in the Memphis project and a study of the problems associated with similar programs for other parts of the region will be helpful in finding effective ways to provide solar water heating systems under attractive financial arrangements. The low-interest rates encolrage consumers to participate in this project. Significant economic benefits to the TVA power system will result from the use of the solar water heaters under this program. TVA intends to make consumers aware of the life-cycle benefits of solar water heating as a part of the TVA solar program.

TVA is currently conducting and planning research and development of solar space heating and cooling, both singly and in cooperation with DOE and with other organizations. TVA is also actively exchanging information with DOE officials to coordinate research and identify the projects which TVA is best qualified to conduct. For example, TVA and DOE are currently working toward the development of an interagency agreement for the application of photovoltaic energy sources in TVA activities. Two applications under consideration are remote area repeater stations and water temperature monitoring required for environmental compliance. TVA and DOE have worked together for several years in connection with the Annual Cycle Energy Systems (ACES) home project at Knoxville, an experiement in residential solar heating and cooling being managed by The University of Tennessee. In addition, a joint DOE–NASA–TVA project to test and evaluate a new dish solar collector which is expected to produce heat suitable for industry in the 400–600°F range is being developed, and the staffs are working toward an interagency agreement.

We expect these TVA conservation programs will be productive in promoting conservation and in reducing demand. As TVA becomes aware of potential new conservation opportunities, it will, of course, continue to add to these programs and modify them. The rate surcharge GAO recommended for future consideration is therefore hypothetical at this time and need not be considered now. We would point out, however, that such a surcharge may be inconsistent with requirements of the TVA Act that rates be as low as feasible and that "electric power shall be sold and distributed to the ultimate consumer without discrimination as between consumers of the same class." In any event, TVA is currenly studying possible rate changes to promote conservation, and an environmental statement and hearings pursuant to PURPA are being scheduled for this year to consider such changes. Any rate changes which may result, together with TVA's other conservation programs, will surely accomplish the goal of eliminating wasteful energy consumption.

10. *Recommendations.*—The Congress should revise TVA's charter to better reflect current national energy priorities. TVA should be charged with:

Leading electricity management plans and programs development,

Encouraging energy conservation and the most efficient production and use of energy,

Encouraging the use of renewable resources, and

Assuring adequate public involvement in energy planning and policymaking.

Response.—TVA believes that no amendment to the TVA Act is necessary at this time because the energy priorities suggested by GAO are within TVA's present authority and are being aggressively pursued.

TVA, long a leader in electricity management plans and programs, has the largest interruptible load of any power supplier in the United States and is also a leader in system load factor. As described above, TVA is implementing the policies and conducting the studies necessary to maintain its position of leadership. This includes TVA's efforts to further increase interruptible load and the many demonstration programs underway, such as remote switches on water and space conditioning equipment.

TVA is providing a yardstick for energy conservation efforts in the Nation. As described in some detail, TVA is working with all classes of consumers to encourage conservation. These programs range from the Home Insulation Program and the program of energy audits and financing assistance for commercial and industrial consumers to rate reform studies, the $uper $aver Electric Home Program and consideration of proposed service practice standards such as residential insulation requirements.

TVA's programs in the use of renewable resources are demonstrating for the Nation the potential effectiveness of such programs. The various solar applications mentioned above, such as the solar water heater demonstration in Memphis, are just one part of this effort. Other efforts include the demonstration

of wood stoves for space heating in rural Georgia, wood pyrolysis and gasahol programs, and our other studies of the potential uses of wood and solid waste as sources of energy.

The involvement of the public in energy planning and policymaking at TVA has been achieved in a number of ways which provide a model, not only for energy planning and policymaking, but for decisionmaking by government agencies in general. TVA opened its Board meetings to the public long before the enactment of the Sunshine Act and has continued to encourage dialogue between the public and the Board at those meetings. In addition to seeking public comment on its environmental statement on policies concerning rates, conducting numerous public hearings on rates, and maintaining a continuous dialogue with publicly owned and consumer-owned distributors of TVA power, TVA recently conducted public forum discussions among a number of independent observers of our activities. In the near future TVA, in accordance with PURPA, will conduct public hearings on service practices and rate standards. Environmental statements are now being prepared on power rates and power system planning, and public review will be actively encouraged.

Without further belaboring the point, the TVA Board believes that the TVA Act already provides the necessary authority and purposes to achieve the goals mentioned by GAO without further amendment. If in the future it appears that amendment of the TVA Act is neecssary to permit new policies or programs, TVA will not hesitate to come to Congress and request any appropriate changes.

We appreciate the opportunity to provide you with this information.

Sincerely,

S. DAVID FREEMAN,
Chairman.

PANEL ON REGIONAL ECONOMIC GROWTH AND ELECTRICITY DEMAND

ROBERT A. BOHM

Dr. Bohm received his undergraduate degree (in economics) from Colgate University and his doctorate from Washington University. He joined the staff of The University of Tennessee Department of Finance in 1968 and currently holds the rank of Professor in that Department. He is also Associate Director to The University of Tennessee Environment Center.

In recent years his research activities have related primarily to energy and associated environmental matters.

ROGER S. CARLSMITH

Mr. Carlsmith received his education at Harvard University (B.S. in Chemistry) and at the Massachusetts Institute of Technology (M.S. in Chemical Engineering). He is also a graduate of the Oak Ridge School of Reactor Technology. Since 1955, he has been a member of the research staff of the Oak Ridge National Laboratory and has participated in a wide variety of energy development programs.

Mr. Carlsmith is currently Director of the Energy Conservation Programs at ORNL.

WILLIAM U. CHANDLER

Mr. Chandler was educated at The University of Tennessee. His employment has included the Institute of Energy Analysis in Oak Ridge and he now serves as a Research Associate with the U.T. Environment Center.

JOHN H. GIBBONS

Dr. Gibbons received his undergraduate training at Randolph-Macon and his doctorate from Duke. He came to The University of Tennessee in 1973 from ORNL to direct the newly-formed U.T. Environment Center. In late 1973 he was on leave of absence from the Environment Center to become Dirctor of Energy Conservation in the Federal Energy Administration, returning to UTEC in 1974.

WILLIAM C. GOOLSBY

Dr. Goolsby was awarded the B.A. degree by the University of Southern Mississippi and the doctorate (in economics) by the University of Wisconsin. He

joined the staff of The University of Tennessee College of Business Administration in 1972 and currently holds the rank of Associate Professor of Finance. Since 1977 he has been responsible for the maintenance and development of the Tennessee Econometric Model which is housed in the U.T. Center for Business and Economic Research in the College of Business Administration.

ERIC A. HIRST

Dr. Hirst received his education at Rensselear Polytechnic Institute (B.M.E. in Mechanical Engineering) and at Stanford University (M.S. and Ph.D. in Mechanical Engineering). His professional interests are in policy-oriented research on natural resources, particularly energy use. He has authored more than 70 technical reports, journal articles and book reviews. He previously worked as Director, Office of Transportation Research, Federal Energy Administration, before joining the Energy Division staff as Group Leader in June 1975. He is currently with the Minnesota Energy Agency, on a one-year leave of absence from ORNL.

JOHN R. MOORE

Dr. Moore was educated at Colgate University (undergraduate) and Cornell University (M.A. and Ph.D.) He joined the University of Tennessee in 1953. He has served as Head of the U.T. Department of Economics, and is currently Professor of Economics and Associate Dean of the College of Business Administration.

Load Forecasts

(By Lynn C. Maxwell, Assistant Chief, Analysis Branch)

INTRODUCTION

Load forecasting in today's environment has increased in complexity due to rapid changes in the factors that influence electricity consumption.

The underlying factors which affect future electricity consumption are growing in number and changing rapidly over time.[1]

Historically, the TVA area has experienced rapid economic growth compared to the Nation. Prior to the 1975 recession, gross regional product in the TVA area grew approximately one and a half times as fast as gross national product. Likewise, total employment in the Valley increased much faster than total employment in the United States with much of this growth occurring in manufacturing industries within the Valley.

The rapid historical growth of the TVA area economy has helped close the gap between incomes in the TVA area and the Nation. In 1977 TVA area income per capita reached 80 percent of U.S. income per capita.

Although the Valley has come a long way, we expect that the regional economy will continue to outpace the national economy even though at a somewhat slower pace compared to historical evidence. In the future we expect that much of this growth will occur in the service or commercial industries which reflects underlying structural changes in the regional economy which occurred in the late 1960's and early 1970's.

Although TVA expects the regional economy to grow faster than the national economy, we must realize that there is some uncertainty in forecasting economic growth and other determinants of electricity consumption. In order to proceed on a prudent planning basis, TVA prepares several long-run forecasts to the year 2000.

[1] These factors include changes in the level of economic activity, the effect of higher electricity rates, conservation associated with Federal and State legislation, the substitution of electricity for scarce fossil fuels, and the aggressive development of TVA conservation programs and alternative energy sources such as solar space and water heating.

FORECASTS OF ECONOMIC DETERMINANTS OF ELECTRICITY CONSUMPTION

The basic premise on which TVA load forecasting methodology and procedures are founded is that the demand for electricity is a derived demand determined by the level of economic activity, the price of electricity, the prices and availability of alternative fuels, and conservation and new end-use technology programs designed to increase the efficiency by which electricity is used.

There is a wide variety of determinants of load growth which TVA forecasts in order to prepare alternative load forecasts. Rather than presenting all of the determinants of load growth, the key economic factors which influence loads are presented in Exhibit 1. Since there is uncertainty in forecasting any economic factors, a range of forecasts is provided for the key determinants of load growth.

One of the major determinants is economic activity. Three forecasts of total TVA area employment are indicated in the top part of Exhibit 1, with the high forecast indicating a growth of approximately 2.3 percent per year from 1980–2000 and the low economic growth forecast indicating a growth rate of 1.6 percent per year. By the year 2000 there is a 12 percent difference between the high and low forecasts of regional employment.

Past and future increases in the price of electricity are also important determinants of the increased efficiency in the use of electricity. TVA forecasts the real price of electricity or the price of electricity adjusted to exclude the rate of inflation. The forecast range for the price of electricity varies from a 0 percent change in real price (the price of electricity increasing at the same rate as the inflation rate) to a very high forecast of 4 percent per year. Although a high forecast of electricity prices was prepared, TVA analyses of future revenue requirements indicate that the real price of electricity will increase between 0 and 2 percent per year. TVA's goal is to maintain electricity prices as low as possible although we will encourage conservation through appropriate rate design.

As indicated in Exhibit 1 fossil fuel prices as represented by the real price of natural gas are expected to increase faster than the price of electricity. The rising real price of natural gas will tend to cause a substitution of electricity for scarce fossil fuels. A more complete discussion of the forecast of factors which determine load growth is presented in Appendix A.

TVA CONSERVATION PROGRAMS

Not only do economic factors influence load growth, but conservation programs play a major role in promoting the efficient use of electricity.

As Bob Hemphill has discussed, all of the TVA conservation programs are expected to reduce electricity consumption by 15 to 20 billion kWh by 1990 or the equivalent of three to four large generating units.

LOAD FORECASTS

For each of the major factors determining load growth, a low, medium, and high forecast was prepared; and for TVA conservation programs, a low and high projection are provided. Although a limited number of variations in determinants of load is provided, all possible combinations of these variations in determinants would produce 54 alternative load forecasts.

The alternative load forecasts can be organized with a tree diagram as shown in Exhibit 2. There are four types of branches in the tree—one each for the four major determinants of load: economic activity, price of natural gas, price of electricity, and TVA conservation programs. For each of the first three factors, there are three alternative levels of activity; and for TVA programs, there are two levels of activity.

Combinations of various levels of the determinants of electricity consumption produce 54 alternative forecasts. For example, high economic activity, high price of natural gas or substitution, low price of electricity (0 percent per

year), and low TVA program levels would produce the highest forecast and results in a growth rate of electricity consumption of 5.1 percent per year from 1978–1990. The bottom branches of the tree would produce the lowest forecast and would result in a growth rate of electricity consumption of 2.2 percent per year from 1978–1990. There are, of course, a large number of forecasts between the extremes.

Not all of the alternative forecasts are equally likely to occur. It is expected that the mid-range forecasts between the extreme high and low forecasts have a higher possibility of occurrence.

The forecasts of electricity consumption (kilowatt hours) for 1990 and 2000 for selected forecasts which may be likely to occur are presented in Exhibit 3. These alternative forecasts represent a range of forecasts which deals with the uncertainty in load forecasting. In light of this uncertainty, the range of forecasts provides a prudent planning basis.

The first forecast presented in Exhibit 4 is based on the forecasts of the high level of economic activity, the medium outlook for the price of natural gas (medium substitution), the price of electricity increasing no faster than the rate of inflation (0 percent per year), and the high estimate of the effect of TVA conservation programs. This forecast results in a growth of electricity consumption of 4.6 percent per year from 1978 to 1990 and 3.8 percent per year from 1990 to 2000.

Since the assumption underlying this forecast closely approximately several of TVA's goals, alternative forecasts may seem unnecessary. However, other forecasts must be considered in light of forecasting uncertainty and the need to proceed on a prudent planning basis, recognizing that goals may or may not be achieved.

The fourth forecast in Exhibit 3 represents the same assumptions as the first but with total employment being 8 percent lower in 1990 and 12 percent lower in the year 2000 and the effect of TVA conservation programs being slightly less. The growth rate of electricity consumption in the forecast is expected to be 3.7 percent per year from 1978–1990 and 2.8 percent per year from 1990–2000.

The second and fifth forecasts are the same as the first and fourth forecasts except that the real price of electricity increases at 2 percent per year rather than 0 percent during the forecast period. Generally, higher prices of electricity reduce the growth rate of electricity consumption 0.5 to 0.8 of a percentage point year year. In 1990 electricity consumption would decrease by approximately 6 percent. A more complete discussion of the alternative load forecasts is presented in Appendix B.

EXHIBIT 1

FORECASTS OF DETERMINANTS OF LOAD GROWTH

	Low	Medium	High
Total regional employment (thousands):			
1978	2,588	2,588	2,588
1980	2,708	2,708	2,708
1990	3,214	3,311	3,477
2000	3,730	3,972	4,261
Growth rate: 1980–2000 (percent)	1.6	1.9	2.3
Price of electricity (mills per kilowatt-hour in constant 1972 dollars):			
1978	13.8	13.8	13.8
1980	14.9	15.2	15.2
1990	14.9	18.2	22.5
2000	14.9	21.8	33.3
Growth rate: 1980–2000 (percent)	0	1.8	4.0
Residential price of natural gas (1972 dollars per thousand cubic feet):			
1978	1.21	1.21	1.21
1980	1.49	1.49	1.49
1990	1.78	2.16	2.62
2000	2.17	3.17	4.69
Growth rate: 1980–2000 (percent)	1.9	3.9	5.9

Source: Projections of price of gas through 1990 are based on Data Resources Inc. "Autumn 1978 Energy Review."

EXHIBIT 2

ALTERNATE LOAD FORECASTS

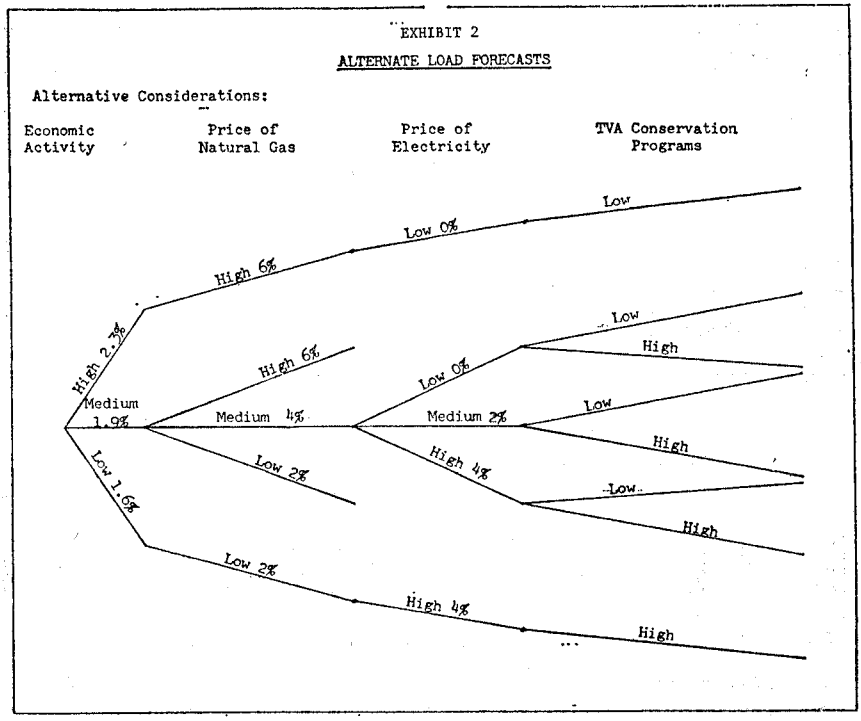


EXHIBIT 3

ALTERNATE LOAD FORECASTS—NET SYSTEM REQUIREMENTS

	Billi9ns of kilowatt-hours		Average annual growth rate [1]	
	1990	2000	1978–90	1990–2000
1. High economic growth, medium substitution, 0 percent change in electricity price, high effect of conservation programs	210.1	306.0	4.6	3.8
2. High economic growth, medium substitution, 2 percent change in electricity price, high effect of conservation programs	197.4	265.3	4.1	3.0
3. Medium economic growth, medium substitution, 0 percent change in electricity price, high effect of conservation programs	192.0	263.7	3.9	3.2
4. Low economic growth, medium substitution, 0 percent change in electricity price, low effect of conservation programs	188.0	247.6	3.7	2.8
5. Low economic growth, medium substitution, 2 percent change in electricity price, low effect of conservation programs	177.1	216.7	3.2	2.0

[1] Fiscal 1978 net system requirements are 121,800,000,000 kilowatt-hours.

APPENDIX A—FORECASTS OF MAJOR DETERMINANTS OF ELECTRICITY CONSUMPTION

SHORT-TERM ECONOMIC OUTLOOK

National economy

The growth of the national economy is expected to slow in the next two years as rising prices and interest rates dampen expenditures by businesses and households. Consumer expenditures are expected to increase moderately, whereas in-

vestment expenditures are expected to decrease due to a recession in the housing industry.

Our current short-term outlook for gross national product (GNP), the major components of expenditures on goods and services, and total employment in the U.S. are presented in Table 1. Under this forecast, GNP is expected to increase 2.6 percent in 1979 and 1.4 percent in 1980. This implies a slowdown in the rate of economic expansion in 1979 and 1980.

While growth will be quite slow with some sectors declining, the overall economy is not expected to experience a recession, although such a possibility exists. In our view, any recession which may develop will be mild and of short duration.

Total employment in the U.S. is expected to increase 2.5 percent in 1979 and 1.7 percent in 1980 compared to total employment growth of 4.1 percent in 1978. It should be noted that total employment is expected to increase at about the same rate as GNP which follows recent short-term trends of very sluggish growth in labor productivity.

TABLE 1.—SHORT-TERM U.S. ECONOMIC OUTLOOK

	Gross national product and components (billions of 1972 dollars)								Total employment (millions)	
	Gross national product		Consumer expenditures		Investment expenditures		Government expenditures			
Year	Amount	Percent change	Amount	Percent change	Amount	Percent change	Amount	Percent change	Amount	Percent change
1977	1,332.6		857.7		196.3		269.2		90.55	
1978	1,384.2	3.9	888.3	3.6	210.2	7.1	275.3	2.2	94.27	4.1
1979	1,420.6	2.6	913.7	2.9	199.8	−5.0	283.8	3.1	96.59	2.5
1980	1,440.4	1.4	930.6	1.8	188.8	−5.5	291.4	2.7	98.19	1.7

Source: Wharton Econometric Forecasting Associates, Short-Term Forecast, November 1978.

Regional economy

The short-term outlook for the regional economy largely reflects the outlook for the U.S. economy as indicated in Table 2. Total employment is expected to increase 2.4 percent in 1979 and 2.2 percent in 1980 compared to 3.5 percent in 1978. In the regional economy, nonmanufacturing employment is expected to increase faster than manufacturing employment reflecting recent historical trends.

Alternative short-term outlook

An alternative to a GNP growth deceleration in both 1979 and 1980 is that a mild recession could occur in 1979 with recovery occurring quickly in 1980. Two or three quarters of negative growth of real GNP implied in this alternative outlook would represent a mild recession with overall growth of GNP being 1 percent in 1979 and a mild recovery of 3 percent in 1980. A recession in 1979 would change the national and regional outlook as outlined in Table 3.

In the United States the percent change in real GNP and total employment would be approximately the same indicating little change in overall labor productivity. In the region, total employment would change in a pattern similar to the Nation. Manufacturing employment would decline in 1979 with recovery in the following year. Nonmanufacturing employment would show little change.

TABLE 2.—TVA REGIONAL EMPLOYMENT OUTLOOK

[In thousands]

	Total employment		Manufacturing employment		Commercial and other employment	
Year	Number	Percent change	Number	Percent change	Number	Percent change
1977	2,499.8		756.7		1,743.1	
1978[1]	2,588.0	3.5	775.0	2.4	1,813.0	4.0
1979[2]	2,649.4	2.4	791.3	2.1	1,858.1	2.5
1980[2]	2,707.6	2.2	803.9	1.6	1,903.7	2.4

[1] Estimated employment in 1978.
[2] Forecast employment based on Division of Navigation Development and Regional Studies forecast of Nov. 22, 1978.

TABLE 3.—NATIONAL AND REGIONAL ECONOMIC OUTLOOK WITH A RECESSION IN 1979

Year	National outlook growth rates of—		Regional outlook growth rates of—		
	Real GNP	Total employment	Total employment	Manufacturing employment	Nonmanufacturing employmentt
1978	3.9	4.1	3.5	2.4	4.0
1979	1.0	1.0	.9	−2.6	2.4
1980	3.0	3.0	3.7	6.4	2.6

LONG-TERM ECONOMIC OUTLOOK

National economy

As in last year's forecast, the long-term outlook continues to reflect several factors affecting employment, productivity, and output growth. The decline in the growth rates of population continues to decrease the growth in the labor force, although this is partially offset by increased participation of women in the labor force. The current dampening of over-all productivity growth is partially due to the substantial number of new entrants to the labor force in the 16- to 24-year age group. Traditionally, this age group exhibits lower average productivity than the older, more experienced workers. As this large bulk of younger workers gains employment experience, improvements in productivity are expected to occur in the mid to later 1980's.

The long-term forecast also indicates that employment in service-oriented industries will increase faster than in manufacturing industries.

The long-term outlook for GNP, employment, and real per capita income is presented in Table 4.

The average annual growth rate of GNP from 1980 to 2000 is approximately 3.0 percent. Growth in total employment declines from 1.4 percent per year from 1980 to 1990 to 1.1 percent from 1990 to 2000, reflecting the slower growth of the labor force. Nonmanufacturing employment increases at a faster rate than manufacturing employment, where nonmanufacturing employment as a percent of total employment increases from 79 percent in 1980 to 82 percent in 2000. Growth of real per capita income reflects a pattern similar to the growth of real GNP.

TABLE 4.—LONG-TERM U.S. ECONOMIC OUTLOOK, SELECTED YEARS

Year	Gross national product (billions of constant dollars)		Employment (millions)						Real per capita personal income	
			Total		Manufacturing		Nonmanufacturing			
	Amount	Percent change[1]	Number	Percent change[1]	Number	Percent change[1]	Number	Percent change[1]	Amount	Percent change[1]
1980	1,440		98.2		20.8		77.4		4,033	
1985[2]	1,683	3.2	106.2	1.6	21.5	0.7	84.7	1.8	4,517	2.3
1990[3]	1,921	2.7	112.6	1.2	21.6	.1	91.0	1.5	4,923	1.6
2000[3]	2,574	3.0	125.0	1.1	22.3	.3	102.7	1.2	6,107	2.2

[1] Average annual percent change for periods indicated.
[2] Forecast based on Wharton Econometric Forecasting Associates long-term forecast of September 1978.
[3] Forecast based on Wharton Econometric Forecasting Associates long-term forecast extended to 2000 of July 1978.

TABLE 5.—LONG-TERM REGIONAL ECONOMIC OUTLOOK[1]

Year	Employment (thousands)						Real per capita income	
	Total		Manufacturing		Nonmanufacturing			
	Number	Percent change	Number	Percent change	Number	Percent change	Amount	Percent change
1980	2,708		804		1,904		3,307	
1985	3,013	2.2	862	1.4	2,151	2.5	3,817	2.9
1990	3,311	1.9	901	.9	2,410	2.3	4,283	2.3
2000	3,972	1.8	1,005	1.1	2,967	2.1	5,618	2.8

[1] Forecast based on Division of Navigation Development and Regional Studies forecast of Nov. 22, 1978.

Regional economy

The growth history of the regional economy indicates a strong growth potential in total employment. In our current forecast, total employment as shown in Table 5 will increase 2 percent per year from 1980 to 2000 compared to 1.2 percent in the Nation. Faster regional economic growth compared to the Nation reflects historical trends in the growth of total employment. From 1955 to 1977, U.S. total nonagricultural employment increased 2.1 percent per year compared to a 3.2 percent-per-year increase in TVA area total nonagricultural employment.

The major difference in this year's regional economic outlook and last year's outlook is in the composition of employment growth between manufacturing and nonmanufacturing sectors. Last year's regional economic outlook indicated that manufacturing employment as a percent of total employment would remain fairly stable although an alternative regional outlook examined the potential for a decline in manufacturing employment as a percent of total employment.

In the development of this year's regional economic outlook, an extensive examination was undertaken of the factors which are likely to determine the growth of the manufacturing sector of the regional economy compared to the Nation. From this examination, it was determined that relative wages and relative power costs for the region compared to the Nation were the important determinants of industrial location. In the regional forecast, wage rates in the region as a percent of U.S. wage rates increase from 79 percent in 1980 to 90 percent in 2000. Power costs in the region as a percent of national power costs increase from approximately 75 percent in 1980 to 90 percent in 2000. The increases in relative wage rates and power costs tend to decrease the growth potential for manufacturing in the region.

In addition to the examination of the manufacturing sector, the long-term trends in the growth of nonmanfacturing employment as a percent of total employment were reviewed. Prior to 1967, manufacturing employment as a percent of total employment increased. From 1967 to 1977, manufacturing employment as a percent of total employment declined from approximately 35 percent to 30 percent. As indicated in Table 5, nonmanufacturing employment increases at a faster rate than manufacturing employment. From 1980 to 2000, manufacturing employment as a percent of total employment is projected to decrease from 30 percent to 25 percent. Throughout the forecast period, the regional composition of employment approaches that of the Nation.

The growth of real income per capita reflects the increase in relative wages and historical trends of regional per capita income. TVA area per capita income as a percent of U.S. per capita income is 82 percent in 1980 and 92 percent in the year 2000.

Alternative regional outlook

In addition to the regional forecast described above, two alternative regional forecasts were prepared for use in planning studies. The first of these continues the historical pattern of expansion by assuming that relative wages remain constant throughout the planning period. This results in manufacturing employment levels that are 17 percent higher by the year 2000 and somewhat smaller increases in total employment and population. A second alternative considers the implications of lower employment growth in the region. The lower forecast would result if regional wages and power costs were the same as the Nation in the year 2000. A comparison of the expected total employment in all three alternative regional economic forecasts is presented in Table 6.

TABLE 6.—ALTERNATIVE REGIONAL ECONOMIC FORECASTS, TOTAL EMPLOYMENT

[In thousands]

Year	Medium economic growth	Percent change	Low economic growth	Percent change	High economic growth	Percent change
1980	2,708		2,708		2,708	
1990	3,311	2.0	3,214	1.7	3,477	2.5
2000	3,972	1.8	3,730	1.5	4,261	2.1

OUTLOOK FOR THE PRICE OF ELECTRICITY

The most important change in assumptions from the July 1978 load forecasts is in the outlook for the price of electricity.

In the July 1978 load forecasts, the real price of electricity was unchanged in real terms from 1978 to 1990 as indicated in Table 7. In the July 1978 load forecasts, the real price of electricity increased slightly in 1978 and 1979 and then declined in real terms through 1986–1987 and then increased slightly in real terms from 1987 to 1990.

The revised outlook for prices is shown for three alternatives—low, medium, and high—in Table 7. All three alternative forecasts are substantially higher than the July 1978 forecast in the short run. In the long run, the low forecast indicates no change in the real price of electricity from 1980 through 2000. The medium forecast indicates a 2-percent-per-year increase in the real price of electricity; whereas, the high forecast indicates a 4-percent-per-year increase in the price of electricity.

After an examination of the assumptions which underlie the electricity price forecast, it is believed that the low to medium price forecast is more likely than the high forecast.

A comparison of the price of electricity outlook used in the July 1978 forecasts and the current alternative price forecasts is presented in Figure 1.

TABLE 7.—OUTLOOK FOR PRICE OF ELECTRICITY REVENUE REQUIREMENTS (MILLS PER KILOWATTHOUR)

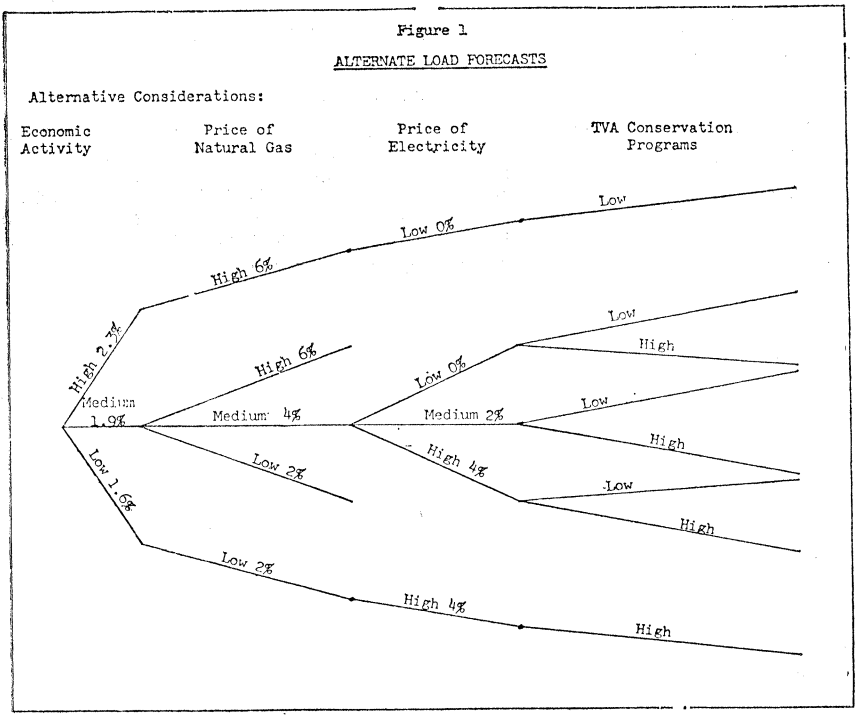
[1972 dollars]

Year	July 1978 load forecast	Percent change [1]	Revised forecast					
			Low	Percent change [1]	Medium	Percent change [1]	High	Percent change [1]
1977	11.9	----------	11.9	----------	11.9		11.9	----------
1978	13.1	10.1	13.8	16.0	13.8	16.0	13.8	16.0
1979	13.6	3.8	15.2	10.0	15.2	10.0	15.2	10.0
1980	13.1	−3.7	14.9	−2.0	15.2	0	15.2	0
1990	12.9	−.2	14.9	0	18.2	1.8	22.5	4.0
2000	12.9	0	14.9	0	21.8	1.8	33.3	4.0

[1] Average annual percent change for period indicated.

Figure 1

ALTERNATE LOAD FORECASTS



OUTLOOK FOR PRICE OF NATURAL GAS

The recent National Energy Act includes a provision for the deregulation of natural gas by 1985 with substantial increases in the ceiling price from 1978 through 1980.

The outlook for the residential, commercial, and industrial price of natural gas is presented in Table 8. The reference case forecast is based on the Data Resources, Inc., energy review of autumn 1978. These forecasts are derived from a U.S. energy model which accounts for the interaction of the supply and demand for alternative fuels.

The reference case forecast indicates that the real price of natural gas will increase substantially in the short run. The real price of natural gas to commercial and industrial customers will increase 35 percent between 1978 and 1980. In the long run, natural gas prices will increase approximately 4 percent per year in real terms in both the residential sector and in the commercial and industrial sector.

A low and a high forecast which bounds the reference case was also prepared. The results for the commercial and industrial price of natural gas are presented in Table 8. Beyond 1980 real natural gas prices are increasing approximately 2 percent per year in the low case and 6 percent per year in the high case.

TABLE 8.—OUTLOOK FOR PRICE OF NATURAL GAS

[1972 dollars per thousand cubic feet]

	Reference case [1]				Low		High	
Year	Residential	Percent change [2]	Commercial and industrial	Percent change [2]	Commercial and industrial	Percent change [2]	Commercial and industrial	Percent change [2]
1978	1.21	----------	1.09	----------	1.09	----------	1.09	----------
1979	1.39	14.5	1.33	22.0	1.33	22.0	1.33	22.0
1980	1.49	7.5	1.47	10.5	1.47	10.5	1.47	10.5
1990	2.16	4.2	2.10	3.6	1.73	1.6	2.54	5.6
2000	3.17	4.0	3.12	4.0	2.12	2.0	4.57	6.0

[1] Data Resources, Inc., Autumn 1978 Energy Review, East South Central I, Kentucky and Tennessee.
[2] Average annual percent change for period shown.

TVA CONSERVATION PROGRAMS

There is a wide variety of TVA programs currently underway or soon to be underway which will achieve a substantial amount of conservation.

Since the July 1978 load forecasts were completed, a substantial effort has been put forth in obtaining estimates of the potential for TVA energy programs. The programs, the assumed penetration, and the resulting energy saving in 1990 are presented in Table 9. The conservation programs are expected to result in an electricity saving in 1990 of 14.5 to 20.0 billion kWh.

TABLE 9.—TVA CONSERVATION PROGRAMS

[In millions of kilowatt-hours]

	Assumed penetration	1990 energy savings
A. Residential:		
1. Retrofit programs—Home insulation programs	43,000 homes per year–8 yr	3,100
2. New home programs—$uper $aver home program	36,000 homes per year	2,100
3. Residential heating equipment:		
a. Heat pumps:		
(1) Low estimate	20,000 per year or 222,000 in 1990	800
(2) High estimate	55,000 per year or 628,000 in 1990	2,200
b. Biomass:		
(1) Low estimate	31,000 homes in 1990	170
(2) High estimate	94,000 homes in 1990	500
c. Solar active sytem—retrofit:		
(1) Low estimate	2,800 units in 1990	20
(2) High estimate	28,400 units in 1990	180
4. Solar water heating:		
Low estimate	53,000 units in 1990	150
High estimate	163,000 units in 1990	500
5. Passive solar homes—new homes:		
Low estimate	11,600 units in 1990	70
High estimate	23,200 units in 1990	140
6. Electrified transportation	200,000 vehicles in 1990	−1,400
Total, residential energy savings		5,000–7,300
B. Commercial and industrial:		
1. Solar:		
Low estimate	10–percent penetration	600
High estimate	20–percent penetration	1,200
2. Biomass:		
Low estimate	2–percent penetration	400
High estimate	3–percent penetration	600
3. Commerical and industrial energy audit program		6,300
4. Cogeneration:		
Low estimate	Moderate national and TVA financing incentives.	2,200
High estimate	30–percent tax credit TVA loans	4,600
Total commercial and industrial energy savings		9,500–12,700
Total energy savings		14,500–20,000

Appendix B—Load Forecasts

The July 1978 load forecasts explored the impact on electricity consumption of TVA conservation programs and the development of new end-use technologies. Revisions to the July 1978 forecasts have included several changes: (1) an improved regional economic outlook, (2) changes in the outlook for electricity prices, (3) changes in the estimates of TVA conservation and new technology programs based on estimates of the potential effect provided by those responsible for the programs, (4) an examination of a wider variety of changes in load due

to economic and noneconomic factors, and (5) changes in the peak and hourly load forecast based on an analysis of individual residential conservation programs.

COMPARISON OF FEBRUARY 1979 AND JULY 1978 LOAD FORECASTS

A comparison of the July 1978 and February 1979 forecasts is presented in Tables 1 and 2. In Table 1, a comparison of forecasts of net system requirements is presented based on the Medium Economic Growth—Expanded Conservation forecast for 1990. The top line indicates the net system requirements based solely on economic and demographic factors. The February 1979 forecast is based on the medium regional economic forecast excluding the shift to services industries.

TABLE 1.—COMPARISON OF FORECASTS 1990—MEDIUM ECONOMIC GROWTH—EXPANDED CONSERVATION

[In billions of dollars]

Factors influencing change	July 1978 forecast[1]	Revised forecast February 1979
Economic growth and demographic factors	250.3	244.2
Conservation:		
Price	−17.5	−43.6
National programs	−5.2	−2.0
TVA programs:		
Home insulation programs	−2.0	−3.4
Super Saver home program		−2.3
Heat pump	(−3.2)	−2.4
C. & I. energy audits	−5.9	−5.9
Low-interest loans—heat pump	0	+.3
Substitution	+14.4	+14.7
Medium economic growth—expanded conservation	230.9	199.6

[1] For a further discussion of the July 1978 load forecasts, see "July 1978 Load Forecasts," Analysis Branch, Tennessee Valley Authority, 1978.

TABLE 2.—COMPARISON OF FORECASTS 1990—MEDIUM ECONOMIC GROWTH—NEW END-USE TECHNOLOGIES

[In billions of kilowatt-hours]

Factors influencing change	July 1978 forecast[1]	Revised forecast February 1979
Medium economic growth—expanded conservation	230.9	199.6
Shift to services	−8.8	−8.3
New end-use technologies:		
Solar	−4.7	−2.2
Cogeneration	−4.0	−5.0
Monetary incentives	−7.1	−3.9
Appliance efficiency	−3.0	0
Biomass	0	−1.2
Electric car	+1.4	+1.5
Substitution	+11.1	+3.3
Medium economic growth—new end-use technologies	215.8	183.8

[1] See "July 1978 Load Forecasts," Analysis Branch, Tennessee Valley Authority, 1978.

The February 1979 forecast, based solely on economic and demographic factors, is approximately 6 billion kWh or 2.4 percent lower than the July 1978 forecast due to: a downward revision in the outlook for directly served industry, a lower economic outlook in the short run, and a revision in the projection of residential customers.

The largest change in the forecast is due to the outlook for the price of electricity. The outlook for prices in the July 1978 forecast indicated a constant real price from 1977 through 2000. The outlook for electricity prices which is included in Table 1 for the February 1979 load review indicates substantial increases in the real price of eelctricity for 1979 and approximately a 2-percent-per-year increase from 1980 to 2000. The increases in price reduced the forecast for 1990 by 26 billion kWh.

There are some revisions in the 1979 estimates of TVA conservation programs reflecting expansion of the home insultation program and acceleration of the $uper $aver home and heat pump programs.

The overall decrease in net system requirements is approximately 31 billion kWh of which increases in the price of electricity account for 85 percent of the change in electricity consumption.

In Table 2 a comparison of the forecasts on the basis of the Medium Economic Growth—New End-Use Technologies forecast is presented. Overall, there have been some downward revisions in the effect of some TVA programs and a reduction in the substitution of electricity for scarce fossil fuels since a lower forecast of natural gas prices was utilized as an alternative in the February 1979 forecast.

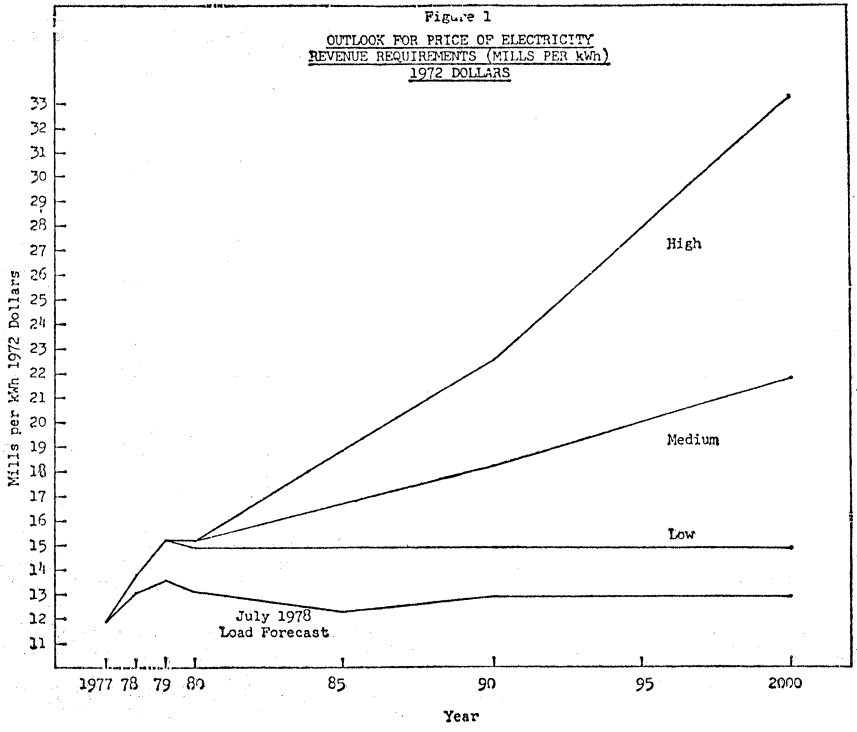
The difference in net system requirements is approximately 32 billion kWh, again largely reflecting increases in the price of electricity.

REVISED LOAD FORECASTS

Electric Energy Forecasts.—A range of alternative forecasts of factors such as economic activity, the price of electricity, the price of natural gas, and TVA conservation programs provides the basis for determining a range of electricity forecasts.

For each of the major factors determining load growth, a low, medium or reference, and high forecast were prepared; and for the TVA conservation programs, a low and high projection are provided. Although a limited number of variations in determinants of load is provided, all possible combinations of these variations in determinants would produce a large number of alternative load forecasts.

The alternative load forecasts can be organized with a tree diagram as shown in Fgure 1. There are four alternative types of branches in the tree—one each for the four determinants of load: economic activity, price of natural gas, price of electricity, and TVA programs. For each of the first three factors, there are three alternative levels of activity; and for TVA programs, there are two levels of activity.



Combinations of various levels of the determinants of electricity consumption produce alternative forecasts. For example, high economic activity, high price of natural gas or substitution, low price of electricity (0 percent per year), and low TVA program levels would produce the highest forecast; whereas, the bottom branches of the tree would produce the lowest forecast. The percentages on the top of each branch of the tree represent the average annual growth rate from 1980 to 2000 of the determinants of electricity consumption. For example, the reference case growth rate for economic activity (total regional employment) is 1.9 percent per year with a high forecast of 2.3 percent per year and a low forecast of 1.6 percent per year.

Rather than presenting all of the alternative forecasts, seven selected forecasts of net system requirements for 1990 are presented in Table 3. For comparison purposes, the forecasts prepared in July 1978 are also shown.

The forecasts are lower due to the upward revisions in the outlook for price of electricity. In 1990 there is a wide range of forecasts from an extreme low of 158.7 billion kWh to an extreme high of 219.9 billion kWh with growth rates of 2.2 to 5.1 percent per year, respectively. Excluding the DOE loads, the growth rates range from 1.0 to 4.5 percent per year.

In the middle range forecasts, the growth rates including the DOE loads range from 3.2 to 4.6 percent.

Within the middle range of forecasts, one of the more likely forecasts is based on projections of a high level of economic activity, medium outlook for the price of natural gas (medium substitution), the price of electricity increasing no faster than the rate of inflation (0 percent per year), and the high estimate of the effect of TVA conservation programs. This forecast (labeled No. 2 in Table 3) results in a growth of electricity consumption of 4.6 percent per year from 1978 to 2000 including the DOE loads.

TABLE 3.—ALTERNATIVE LOAD FORECASTS; NET SYSTEM REQUIREMENTS 1990

	Billions of kilowatthours	Average annual growth rate,[1] 1978–90 (percent)	
		Includes DOE	Excludes DOE
HIGH FORECAST			
1. High economic growth, high substitution, 0 percent change in electricity price, low TVA programs	219.9	5.1	4.5
MIDDLE RANGE FORECASTS			
2. High economic growth, medium substitution, 0 percent change in electricity price, high TVA programs	210.1	4.6	4.1
3. High economic growth, medium substitution, 2 percent change in electricity price, high TVA programs	197.4	4.1	3.4
4. Medium economic growth, medium substitution, 0 percent change in electricity price, high TVA programs	192.0	3.9	3.1
5. Low economic growth, medium substitution, 0 percent change in electricity price, low TVA programs	188.0	3.7	2.9
6. Low economic growth, medium substitution, 2 percent change in electricity price, low TVA programs	177.1	3.2	2.2
LOW FORECAST			
7. Low economic growth, low substitution, 4 percent change in electricity price, high TVA programs	158.7	2.2	1.0
JULY 1978 FORECASTS			
Medium economic growth—expanded conservation	239.6	5.5	5.0
Medium economic growth—new end-use technologies	215.4	4.9	4.3

[1] Fiscal 1978 net system requirements are 121,800,000,000 kilowatthours. DOE requirements are 15,600,000,000 kilowatt hours.

The fifth forecast in Table 3 represents the same assumptions as the first but with total employment being 8 percent lower in 1990 and 12 percent lower in the year 2000 and the effect of TVA conservation programs being slightly less. The growth rate of electricity consumption in the forecast is expected to be 3.7 percent per year from 1978–1990.

The third and sixth forecasts are the same as the second and fifth forecasts except that the real price of electricity increases at 2 percent per year rather than zero percent during the forecast period. Generally, higher prices of electricity reduce the growth rate of electricity consumption 0.5 to 0.8 of a percentage point per year. In 1990, electricity consumption would decrease by approximately 6 percent.

The forecast of net system requirements for the year 2000 is presented in Table 4. These forecasts indicate a range of growth rates from 1990 to 2000 of 0.6 to 4.1 percent per year. Excluding the DOE loads, the growth rates range from 0.8 to 4.8 percent per year. For the middle range forecasts, the growth rates range from 2.0 percent to 3.8 percent.

All of the growth rates from 1990 to 2000 are lower compared to 1978 to 1990 largely due to the zero growth of the Department of Energy uranium enrichment loads from 1985 to 2000. Excluding the DOE loads, the growth rates from 1978 to 1990 are lower than the growth rates from 1990 to 2000 due to the rapid buildup of TVA conservation programs in the early years of the forecast period.

TABLE 4.—ALTERNATIVE LOAD FORECASTS; NET SYSTEM REQUIREMENTS 2000

	Billions of kilowatt-hours	Average annual growth rate, 1990–2000 (percent)	
		Includes DOE	Excludes DOE
HIGH FORECAST			
1. High economic growth, high substitution, 0 percent change in electricity price, low TVA programs	328.8	4.1	4.8
MIDDLE RANGE FORECASTS			
2. High economic growth, medium substitution, 0 percent change in electricity price, high TVA programs	306.0	3.8	4.5
3. High economic growth, medium substitution, 2 percent change in electricity price, high TVA programs	265.3	3.0	3.6
4. Medium economic growth, medium substitution, 0 percent change in electricity price, high TVA programs	263.7	3.2	3.9
5. Low economic growth, medium substitution, 0 percent change in electricity price, low TVA programs	247.6	2.8	3.4
6. Low economic growth, medium substitution, 2 percent change in electricity price, low TVA programs	216.7	2.0	2.6
LOW FORECAST			
7. Low economic growth, low substitution, 4 percent change in electricity price, high TVA programs	169.2	.6	.8
JULY 1978 FORECASTS			
Medium economic growth—expanded conservation	311.9	3.1	3.6
Medium economic growth—new end-use technologies	277.5	2.6	3.1

A graph of several alternative load forecasts compared to the July 1978 Medium Economic Growth—New End-Use Technologies forecast (forecast 6) is presented in Figure 2. Forecast 1 represents the extremely high forecast, and forecast 5 represents the extremely low forecast. Forecasts 2, 3, and 4 represent the middle range forecasts, with forecast 2 representing high economic growth, medium substitution, 0-percent change in electricity prices, and the high estimate of TVA programs. From 1980 to 1986, all of the forecasts are below the July 1978 forecast. This is due to the lower short-term economic outlook, increased prices of electricity, and the rapid buildup of TVA conservation programs, especially the home weatherization program and the commercial and industrial program.

Beyond 1986, the July 1978 forecast is in the upper range of the revised alternative forecasts.

Winter peak requirements forecast

The forecasts of winter peak requirements for 1990 are shown in Table 5.

In the July 1978 new end-use technologies forecast, the 1990 winter requirements were 38,100 MW. The revised forecasts indicate a range of winter peak requirements of 24,700 MW to 36,200 MW. Comparing the July 1978 new end-use technologies forecast of 38,100 MW with the high economic growth, medium

substitution, 0-percent change in price, high TVA programs forecast of 33,900 MW indicates a decrease of 4,000 MW. The increased growth of prices from zero percent per year to 2 percent per year accounts for a decrease in winter peak load of approximately 2,000 MW.

Figure 2

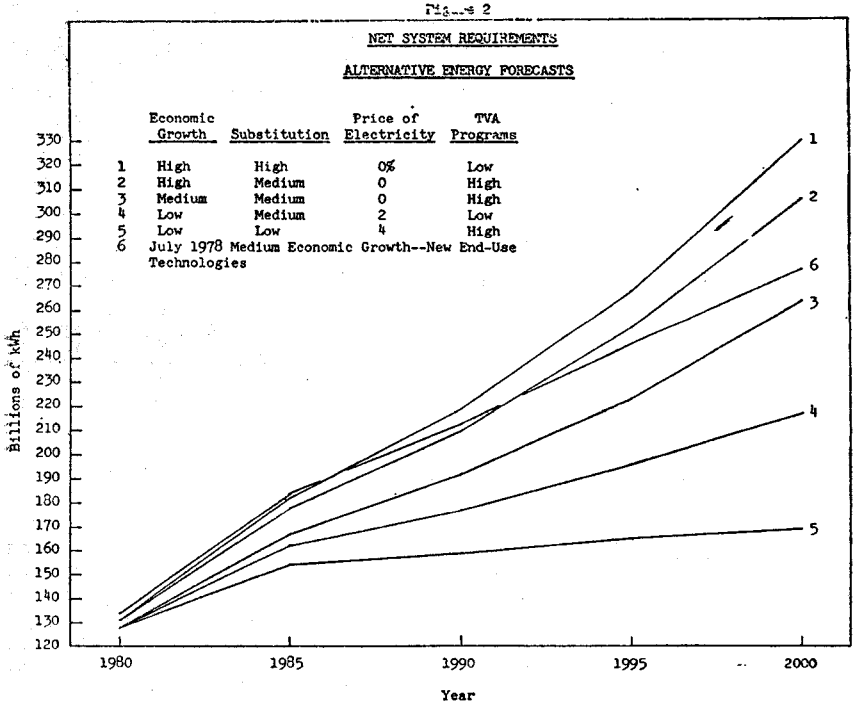


TABLE 5.—ALTERNATIVE LOAD FORECASTS; NET SYSTEM PEAK REQUIREMENTS 1990

	Megawatts	Average annual growth rate,[1] 1978–90 (percent) Includes DOE	Excludes DOE
HIGH FORECAST			
1. High economic growth, high substitution, 0 percent change in ecel-tricity price, low TVA programs	36, 200	4.4	4.3
MIDDLE RANGE FORECAST			
2. High economic growth, medium substitution, 0 percent change in elec-tricity price, high TVA programs	33, 900	3.9	3.6
3. High economic growth, medium substitution, 2 percent change in elec-tricity price, high TVA programs	31, 700	3.3	3.0
4. Medium economic growth, medium substitution, 0 percent change in electricity price, high TVA programs	30, 800	3.0	2.7
5. Low economic growth, medium substitution, 0 percent change in elec-tricity price, low TVA programs	30, 900	3.1	2.7
6. Low economic growth, medium substitution, 2 percent change in elec-tricity price, low TVA programs	29, 050	2.5	2.1
LOW FORECAST			
7. Low economic growth, substitution, 4 percent change in electric-ity price, high TVA programs	24, 700	1.2	.4
JULY 1978 FORECASTS			
Medium economic growth—expanded conservation	39, 900	5.3	5.3
Medium economic growth—new end-use technologies	38, 100	4.9	4 8

[1] January 1978 net system requirements are 21,517 megawatts. DOE requirements are 2,346 megawatts.

The forecast winter peak loads in the year 2000 are presented in Table 6. The revised forecast winter peak loads range from 26,700 MW to 56,100 MW.

A comparison of the growth rates of winter peak load (Table 5) and the net system energy requirements (Table 3) for 1978 to 1990 indicates lower rates of growth for peak loads than for energy. The difference in growth rates ranges from 0.5 to 1.0 percent per year and increases the lower the load forecast. The slower growth rates of peaks than energy are due to the rapid increase in TVA conservation programs in the early years of the forecast. From 1990 to 2000 the peak loads are increasing at approximately the same rate as energy. This is due to a leveling off of the growth of the TVA conservation programs and the constant level of DOE loads which causes a slight decline in the overall system load factor.

TABLE 6.—ALTERNATIVE LOAD FORECASTS; NET SYSTEM PEAK REQUIREMENTS 2000

	Megawatts	Average annual growth rate, 1990–2000 (percent)	
		Includes DOE	Excludes DOE
HIGH FORECAST			
1. High economic growth, high substitution, 0 percent change in electricity price, low TVA programs	56, 100	4.5	5.0
MIDDLE RANGE FORECASTS			
2. High economic growth, medium substitution, 2 percent change in in electricity rrice, high TVA programs	50, 650	4.1	4.6
3. High economic growth, medium substitution, 2 percent change in electricity price, high TVA programs	43, 500	3.2	3.6
4. Medium economic growth, medium substitution, 0 percent change in electricity price, high TVA programs	43, 150	3.4	3.9
5. Low economic growth, medium substitution, 0 percent change in electricity price, low TVA programs	41, 850	3.1	3.5
6. Low economic growth, medium substitution, 2 percent change in electricity price, low TVA programs	36, 350	2.3	2.6
LOW FORECASTS			
7. Low economic growth, low substitution, 4 percent in electricity price, high TVA programs	26, 700	.8	.9
JULY 1978 FORECASTS			
Medium economic growth—expanded conservation	54, 000	3.1	3.4
Medium economic growth—new end-use technologies	51, 000	3.0	3.3

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