United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on Legislative, Committee on Appropriations, House of Representatives

March 2002

AIR QUALITY

TVA Plans to Reduce Air Emissions Further, but Could Do More to Reduce Power Demand

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United States General Accounting Office
Washington, DC 20548

March 8, 2002

The Honorable Charles H. Taylor
Chairman, Subcommittee on Legislative
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

The Tennessee Valley Authority (TVA) operates the nation's largest public power system, supplying electricity to about 8 million customers across a 7-state region. TVA directly serves 62 large federal and industrial customers and serves other commercial, industrial, and residential customers through a network of 158 power distributors. TVA relied on its 11 coal-burning plants to supply about 60 percent of its electric power in fiscal year 2001. These plants account for almost all of TVA's emissions of two key air pollutants—sulfur dioxide (SO2), which has been linked to reduced visibility, and nitrogen oxides (NOx), which contribute to the formation of harmful ozone.[1]

Demand for TVA's electricity will increase about 1.7 percent annually through 2010, according to TVA projections. To meet this demand, TVA estimates that it will need to expand its current generating capacity of 30,365 megawatts[2] by 500 megawatts annually—nearly the equivalent of building an average-size power plant, or contracting for the power from one, every year. Building new generating capacity can result in additional emissions, which raises environmental concerns.

In part to lessen the need for new capacity, TVA and other electricity suppliers promote the efficient use of electricity through "demand-side management" programs, which are designed to reduce the amount of energy consumed or to change the time of day when it is consumed. For example, some utilities offer their customers incentives to purchase appliances and lighting that use less electricity. When current customers

[1]Ozone is a colorless gas that occurs both in the earth's upper atmosphere and at ground level. We use the term ozone to refer to ground-level ozone.

[2]This total refers to net dependable capacity during the winter and includes both base load capacity (used throughout the day) and peak load capacity (used during times of peak demand).

use less electricity, the utility has to generate less power and thus may produce fewer emissions of air pollutants.

Concerned about TVA's dual challenge of reducing emissions while managing increased demand on its power system, you asked us to: (1) determine how TVA plans to meet future demands for electricity through 2005 while minimizing its emissions of SO2 and NOx; (2) describe the scope and impact of TVA's demand-side management efforts; and (3) compare the scope and impact of TVA's demand-side management efforts to those of selected other utilities' efforts.

Results in Brief

Even though TVA intends to increase its capacity to generate electricity through 2005, it also expects to reduce its SO2 and NOx emissions during the same time period, primarily by (1) burning lower-sulfur coal, (2) installing devices to control emissions at its existing plants, and (3) relying on fuels other than coal for new capacity. TVA expects to expand its capacity by more than 10 percent through 2005, with 79 percent of the increase slated to come from upgrading existing facilities and constructing new noncoal-burning facilities, such as turbines that run on natural gas or oil. TVA projects that its SO2 emissions will decline to 525,000 tons (a 28-percent decrease from the 2000 level) and its NOx emissions will decline to 216,000 tons (a 25-percent decrease from the 2000 level).

Although TVA's demand-side management programs provide opportunities for thousands of its customers to reduce their consumption of electricity, these programs make modest contributions to reducing peak-time demand—an average of 41 megawatts annually between 1996 and 2000 (equivalent to 1/10th of 1 percent of TVA's peak capacity). This reduction is less than it otherwise could be, in part because TVA has limited the scope of its key program to reduce peak-time consumption by residential customers; TVA believes the program is not cost-effective. TVA projects that its demand-side programs will produce nearly twice as much in savings during the period 2001 through 2005 as was achieved in the previous 5 years. However, about a third of this projection is based on the expected success of a program that began in June 2001. In October 2001, TVA began an evaluation of short-term opportunities to improve and expand its demand-side management programs.

Other large utilities have more fully implemented the types of programs that TVA currently has in place and have also implemented a greater array of demand-side management tools. For example, like TVA, Florida Power and Light offers its residential customers a bill credit for allowing their

water heaters and air conditioners to be switched off during periods of peak demand. However, Florida Power and Light has involved a much higher proportion of its residential customers in its program (about 19 percent) than has TVA (about 2 percent). Unlike TVA, Puget Sound Energy piloted a "time-of-use" program for 300,000 of its 1.4 million residential customers to encourage less electricity use during periods of peak demand. The utility established different prices for electricity used during four periods of the day—ranging from 6.5 cents per kilowatt hour at night to 9 cents per kilowatt hour during the day—and its customers' bills depend on the amount of electricity used during each period. As a result of the program, customers shifted, on average, about 5 percent of their demand from peak to off-peak hours.

In light of the limited scope and impact of TVA's current demand-side management programs when compared to similar programs managed by other utilities and the potential benefits (including reduced emissions) that may be achieved through the use of additional demand-side management tools, we are recommending that TVA evaluate the structure and effectiveness of its current programs, review the longer-term potential applicability of other programs to its power system, and, as appropriate, expand its demand-side management programs.

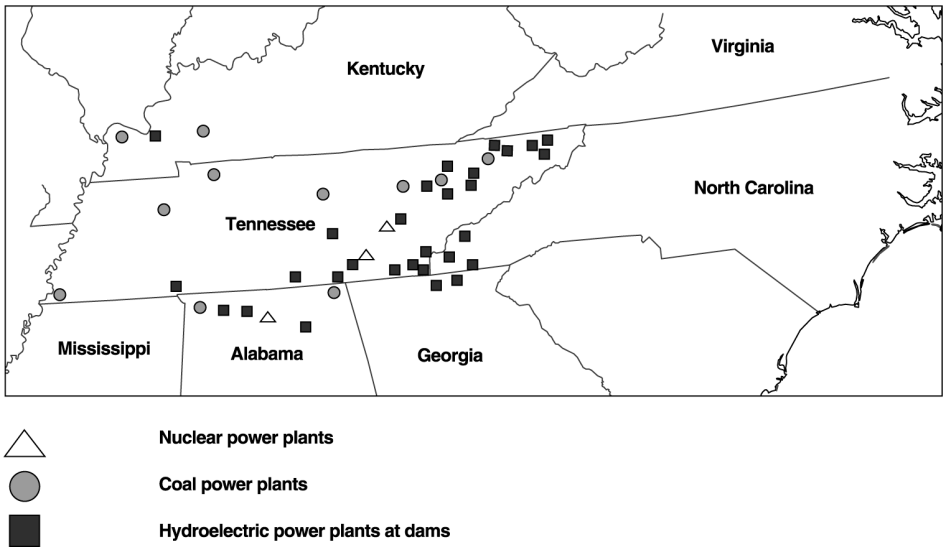
In its February 21, 2002, letter responding to a draft of this report, TVA described initiatives undertaken that are related to our recommendations (see app. III).

Background

TVA was established in 1933 to provide flood control, navigation, and electric power in the Tennessee Valley region. As that area has grown, in both population and economic activity, TVA customers' use of electricity has grown and is expected to keep growing. TVA estimates that demand for its electricity will increase about 1.7 percent annually through 2010.

To meet its customers' demand for electricity, TVA generates electricity not only at its 11 coal-fired plants (consisting of 59 generating units), but also three nuclear power plants (five units), 29 hydroelectric dams (109 units), one pumped storage site (four units), and five sites with combustion turbines (64 units). (See fig. 1.) It also generates power from landfill gas, solar, and wind projects, and it purchases power from others.

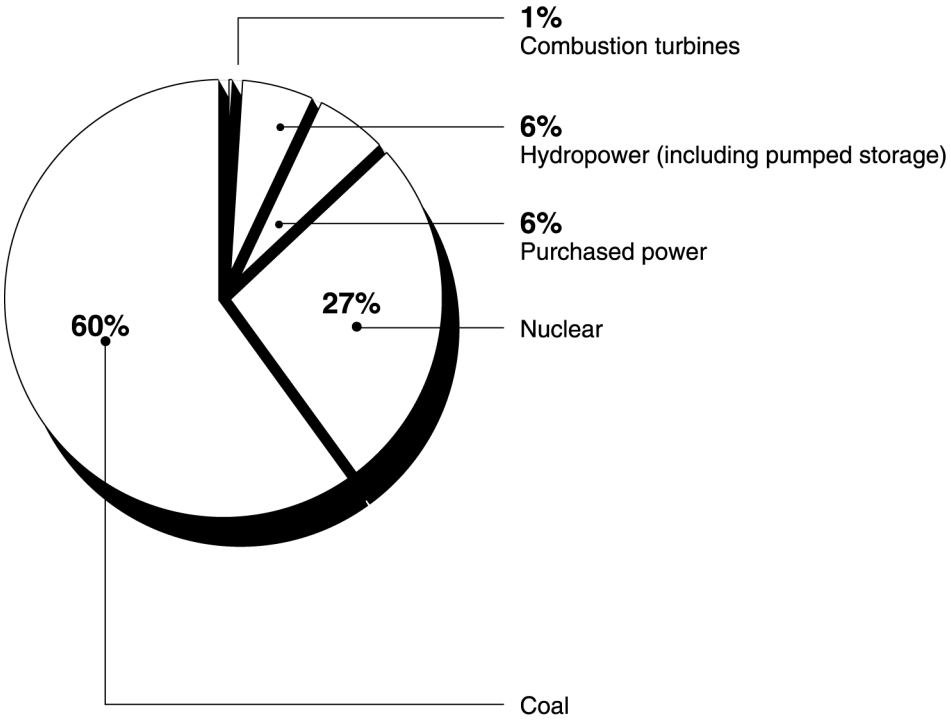
Figure 1: Location of TVA's Principal Power Generating Facilities



From the 30,365 megawatts of generating capacity available from these sources, TVA generated about 156 billion kilowatt-hours of power in fiscal year 2001.[3] It also purchased roughly 9.9 billion kilowatt-hours of power. Of its power supply, 60 percent came from coal, 27 percent from nuclear, 6 percent each from hydropower and power purchases, and 1 percent from combustion turbines. (See fig. 2.)

[3]Kilowatt-hours and megawatt-hours measure energy flows, while kilowatts and megawatts measure generating capacity. Thus, 1 megawatt of capacity used for 1 hour equals 1 million watt-hours (1,000 kilowatt-hours) of electric energy.

Figure 2: TVA's Power Supply, by Source, Fiscal Year 2001



Source: TVA.

Note: TVA also generated power in fiscal year 2001 from "green" sources (solar, landfill gas, and wind), which combined formed less than 1 percent of power generated.

The share of electricity generated by burning fossil fuels has implications for the environment. Burning fossil fuels produces SO2 and NOx gases, and the Environmental Protection Agency estimates that fossil fuel burning from utilities accounted for 67 percent of the nation's SO2 emissions and 27 percent of its NOx emissions in 1999. Both gases can be transported over long distances following the patterns of air movements. SO2 emissions contribute to the production of airborne sulfate particles that contribute to acid rain, which can harm waters, forests, and materials. In addition, these particles can block the transmission of light, resulting in haze in urban areas and the degradation of scenic vistas in many national parks. NOx is also a source of acid rain and, through chemical reactions in the atmosphere with other pollutants, leads to the formation of ground-level ozone, the principal component of smog. Smog can cause chronic human health effects, particularly respiratory problems, as well as harming plants.

TVA's choices in generating power are constrained by laws, regulations, and internal policies. For example, the Clean Air Act, as amended, limits emissions of SO2 and NOx from coal-fired power plants. Moreover, the Tennessee Valley Authority Act, which established TVA, provides that the generation of power from hydroelectric units is a lower priority than navigation and flood control. Finally, an internal TVA policy limits the time period when TVA can draw down the lakes (reservoirs) that it manages for flood control and in the process generate hydropower.

To meet its customers' increasing demand for electricity, TVA can upgrade its existing plants, construct new plants, purchase power from others, or—as an alternative to finding additional supply sources—provide incentives to its customers—called "demand-side management"—to reduce or shift their demand for electricity.

The Department of Energy defines demand-side management as actions taken on the customer's side of the meter to change the amount or timing of energy consumption and identifies several types of programs.

- Energy efficiency programs involve the use of technologies that reduce total energy use, during both peak and off-peak periods, such as energy-efficient lighting, appliances, and building equipment.

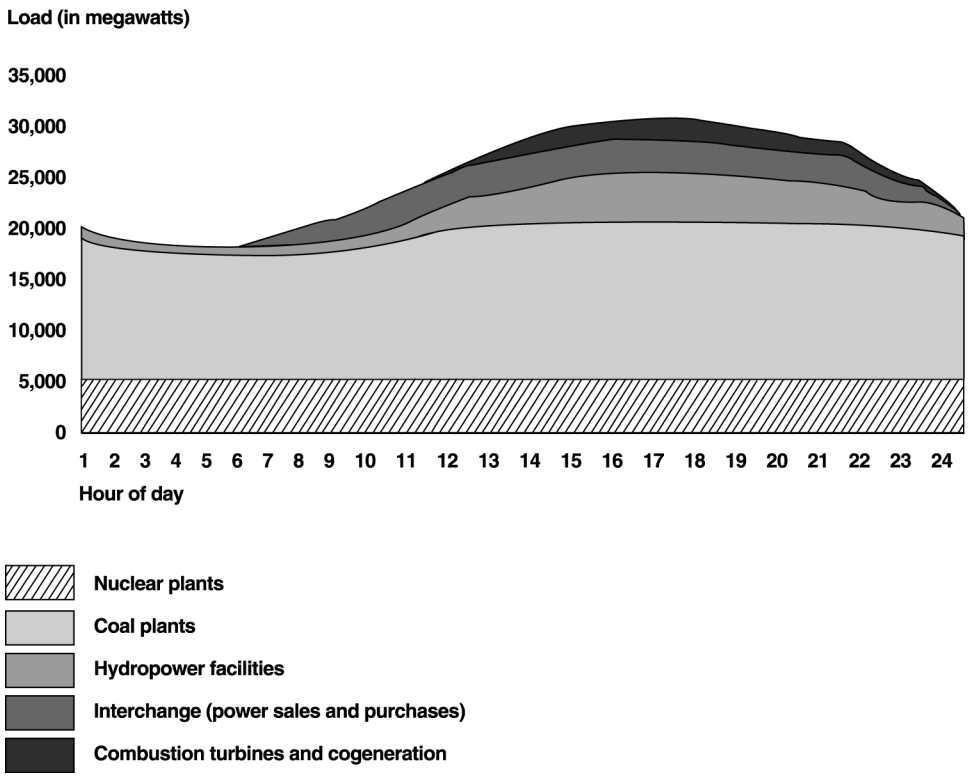
- Peak load reduction programs focus on reducing load during periods of peak power consumption on a utility's system. These programs can involve the use of technologies that smooth out the peaks (called "peak shaving") in energy demand. Such technologies include control systems, such as switches attached to heating, cooling, and ventilation systems that allow the systems to be turned off during peak load times. They can also include rate-schedule programs where utilities structure their rates to encourage customers to modify their pattern of energy use.

According to the Department, utility funding for demand-side management programs in the United States declined nationally between 1994 and 1998, due in large part to increased competition and uncertainties regarding electricity deregulation. Funding for these programs leveled out in 1999 and slightly increased in 2000 as concerns over electric supply shortages in California led many utilities and state regulatory agencies to increase their emphasis on demand-side management.

TVA can benefit from demand-side management, especially reducing peak loads, because electricity use varies substantially within a 24-hour period. For example, on August 17, 2000, an unusually hot day, TVA customers

used about 67 percent more electricity during the hour of highest consumption (4 p.m.) than the hour of lowest consumption (5 a.m.). TVA used its various energy sources in a sequenced manner to supply this electricity. (See fig. 3.) Nuclear facilities provided power steadily throughout the day, while coal facilities provided power fairly consistently—somewhat lower at night and higher during the day. As demand increased during the afternoon, TVA increased the use of hydroelectric power and it purchased power from other utilities. Finally, during the hottest, mid-day hours, TVA used its combustion turbines. Even though TVA's customers used more electricity on that day than on any other in its history, TVA officials told us that the sequencing of power sources was standard practice.

Figure 3: TVA's Sources of Electricity Supply, by Hour, on a High-Demand Day



Source: TVA.

Note: The figure details TVA's load and supply for Aug. 17, 2000. Coal generation includes coal burned to move water to pumped storage and hydro generation includes power generated from pumped storage.

TVA Plans to Reduce SO2 and NOx Emissions but Increase Generating Capacity

TVA projects that its SO2 and NOx emissions in 2005 will fall 28 percent and 25 percent, respectively, below its 2000 levels, despite a planned addition of 3,086 megawatts of generating capacity. TVA projects that its SO2 emissions will decline as it increasingly uses coal with a lower sulfur content at some of its coal-burning power plants. TVA projects that its NOx emissions will decline as it installs more control devices at its coal-burning plants. Moreover, TVA plans to increase its generating capacity largely from sources—other than coal-burning plants—that generally emit less of these pollutants. Aside from constructing new generating capacity, TVA also plans to continue purchasing peak power in a range between 1,500 and 3,000 megawatts annually during the 2001 to 2005 period. (The emissions associated with purchased power—equivalent to 6 percent of TVA's power supply—are not included in TVA's emissions data.) Finally, TVA estimates that its demand-side management programs will offset new peak demand by 396 megawatts between fiscal year 2001 and 2005.

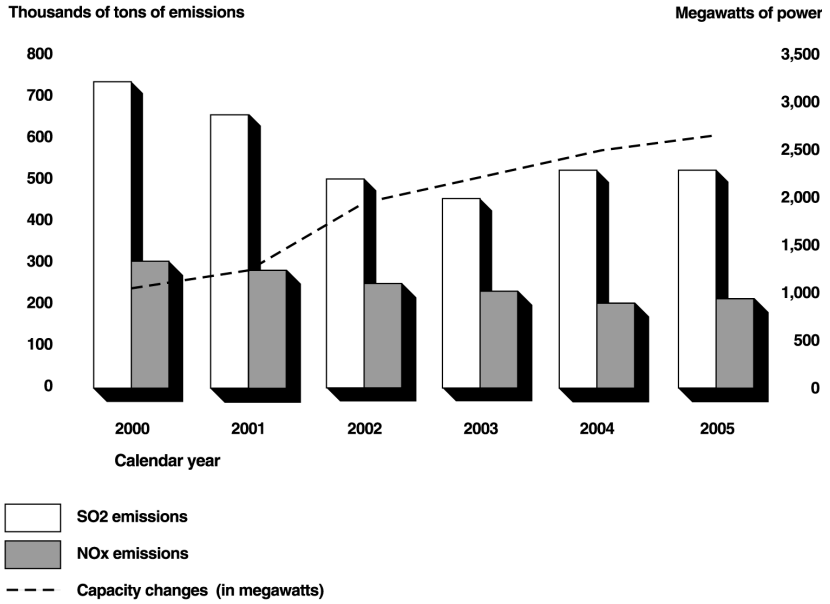
TVA Plans to Continue Reducing SO2 and NOx Emissions

TVA projects that the SO2 emissions from its coal-burning plants will decline from 727,000 tons in 2000 to 498,000 tons in 2003, before rising to 525,000 tons in 2005. (See fig. 4.) According to a TVA official, the expected increase after 2003 is directly related to planned increases in generating capacity at its coal plants. TVA attributes overall projected declines in SO2 emissions to the continued switching to coal with lower sulfur content at three plants.[4] Specifically, the lower sulfur coal is 0.5 to 0.6 percent sulfur, about half the sulfur content of the coal that is currently burned at these units. Moreover, according to the same official, even though SO2 emissions will increase slightly from 2003 to 2005, the average emissions rate will remain unchanged during this period.[5]

[4]TVA officials told us that lower sulfur coal is likely to be used at its Colbert, Alabama; Gallatin, Tennessee; and Paradise, Kentucky, coal plants.

[5]Measured in pounds of SO2 emitted per million British thermal units of heat generated.

Figure 4: TVA Expects Its SO2 and NOx Emissions to Decrease, and Its Capacity to Increase, Through 2005



Source: TVA.

Beyond 2005, TVA has committed to further reduce SO2 emissions. In October 2001, TVA announced that it would install five additional scrubbers to limit SO2 emissions at its coal-burning plants between 2006 and 2010.[6] According to a senior TVA official, annual SO2 emissions from TVA coal-burning plants are likely to fall to around 400,000 tons by 2010.

TVA's projections show a steady decline in its NOx emissions, from 287,000 tons in 2000 to 216,000 tons in 2005. TVA attributes this projected decline to the planned installation of "selective catalytic reduction" systems—which remove nitrogen oxides from the exhaust gases—at some of its generating units at its coal-burning plants. TVA's first such system began operating in 2000. According to TVA, by spring 2005 it will have installed 18 of these systems, or similar such systems, which will control NOx emissions on 25 of its 59 generating units.

[6]TVA committed to installing two scrubbers at its Kingston, Tennessee, coal plant and single scrubbers at its Bull Run, Tennessee; Colbert, Alabama; and Paradise, Kentucky, coal plants.

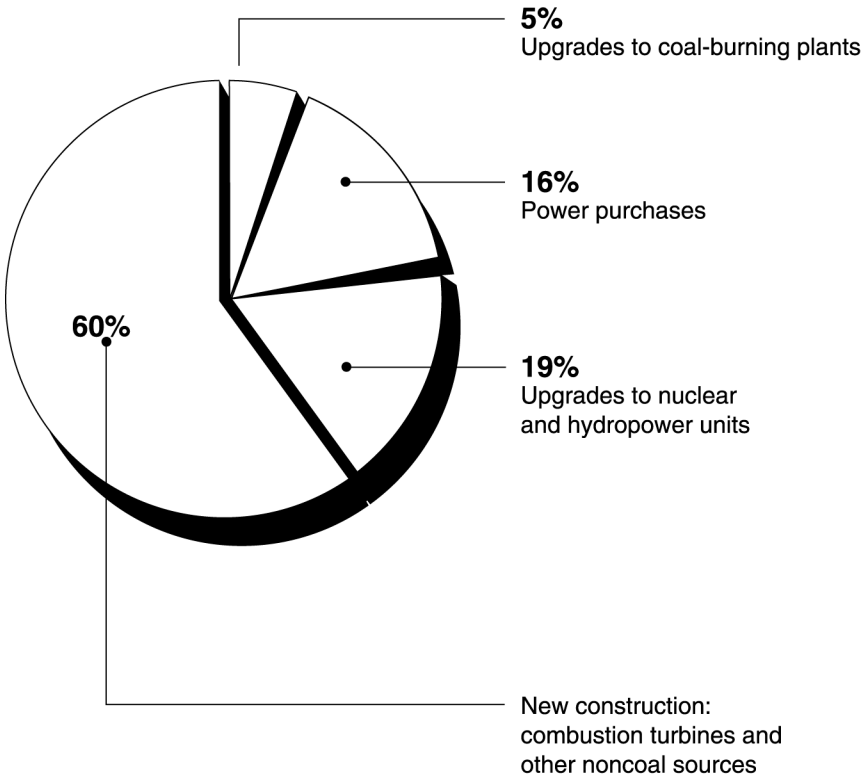
Moreover, TVA expects to make even sharper cuts in its NOx emissions during the summer "ozone season" that extends from May through October. Ozone levels are higher during these months because emissions levels of NOx and natural hydrocarbons are higher, and there is more sunlight, all of which are needed for the formation of ozone, as well as higher temperatures, which speed up the chemical reactions. TVA expects its ozone-season NOx emissions to fall from 118,000 tons in 2000 to 43,000 tons in 2005.

(Additional information on TVA's SO2 and NOx emissions from 1974 through 2010 is included in apps. I and II of this report, respectively.)

Capacity Increases to Come Mainly from Energy Sources Other Than Coal

Of the 3,086 megawatts of additional capacity that TVA plans to add between 2001 and 2005, more than half (1,658 megawatts) will come from "peaking" units, which are used only during the parts of the day when demand spikes. The rest of the new capacity (1,428 megawatts) will be base load units, which are used throughout the day. Most of this increased capacity will be generated through hydropower, natural gas, nuclear power, and other noncoal sources. (See fig. 5.)

Figure 5: TVA Plans to Rely Primarily on Sources Other Than Coal to Meet Demand, 2001-05



Source: TVA.

To increase its base load capacity, in December 2001 TVA began purchasing power from a new 440-megawatt coal-burning lignite power plant in Mississippi. Although TVA does not own the plant, it purchases all of the facility's output. To further increase its base load capacity, TVA plans both to upgrade existing units and to build new capacity:

- constructing a 500-megawatt, natural gas-fired, combined cycle plant in Tennessee, to begin operating in 2003;
- increasing the base load generating output at the Browns Ferry, Alabama, and Sequoyah, Tennessee, nuclear plants, between 2003 and 2005, by 290 megawatts.
- increasing turbine efficiency at three of its coal-burning plants between 2001 and 2005, adding 153 megawatts of capacity; and
- increasing its acquisition of "green power" (from landfill gas, solar, and wind sources) to 45 megawatts in 2005.

To increase its own peak load capacity, TVA plans to add

- 1,336 megawatts of additional combustion turbine capacity, primarily in 2001 and 2002, at facilities in Mississippi and Tennessee;
- 310 megawatts of capacity between 2001 and 2005 by continuing to modernize its hydropower and pumped storage facilities; and
- 12 megawatts of peak capacity by constructing a battery storage plant in Columbus, Mississippi.

Finally, TVA plans to meet future needs by continuing to purchase power to meet peak-time demand. These purchases are expected to remain in the range between 1,500 and 3,000 megawatts through 2005.

TVA's Demand-Side Management Programs Have Realized Few Savings to Date, but TVA Projects Bigger Savings in the Future

Between fiscal years 1996 and 2000, demand-side management programs reduced TVA's peak load by 204 megawatts (about 41 megawatts a year, or roughly equivalent to 1/10th of 1 percent of its overall capacity).[7] Two programs accounted for these savings: the Energy Right Program, which promotes the installation of energy-efficient heat pumps and other electric appliances; and the Cycle and Save Program, which gives residential customers a bill credit for allowing TVA to switch off their water heaters and air conditioners during peak demand periods. TVA reported no savings from its rate-schedule program for commercial and industrial customers. Due in large part to a new program introduced in mid-2001, TVA plans to achieve a cumulative peak load reduction of 396 megawatts for the fiscal year 2001 through 2005 period (about 80 megawatts a year). Finally, TVA is studying ways to expand its demand-side management programs and increase their impact.

TVA's Demand-Side Management Programs Achieved Limited Energy Savings

Each year tens of thousands of customers participate in TVA's demand-side management programs. Such programs involve all major types of customers—commercial, industrial, and residential. Moreover, they are aimed at reducing electricity use both year-round and during peak demand periods.

According to TVA, energy-efficiency and load-reduction programs saved 97 megawatts in fiscal year 2000, and a cumulative total of 204 megawatts

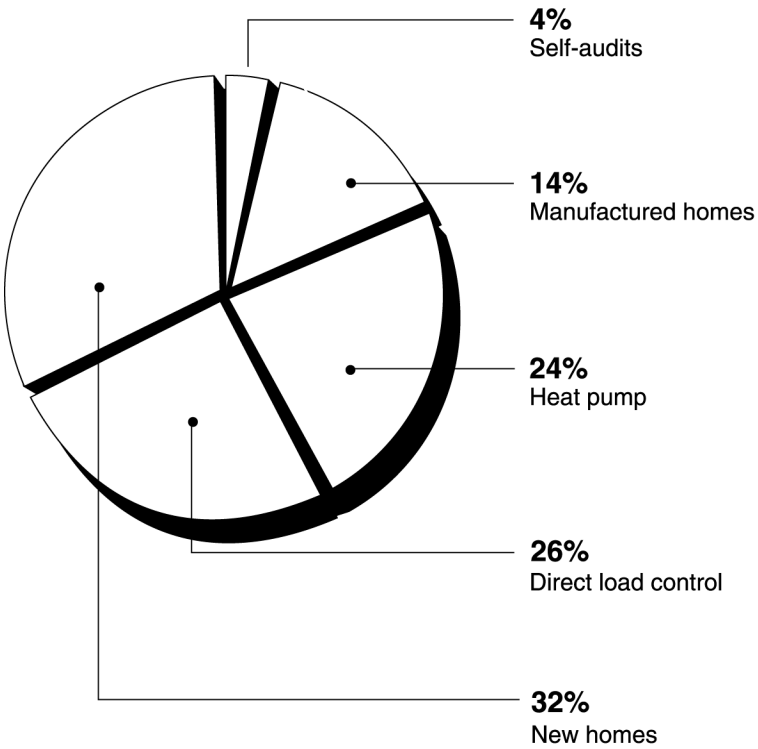
[7]Reductions in peak-time demand are measured in megawatts. They represent reductions in the need to invest in or purchase incremental capacity to meet peak load.

from fiscal years 1996 through 2000. Furthermore, TVA expects these programs to result in an additional 120 megawatts of savings in fiscal year 2005 and a cumulative total of 396 megawatts from fiscal year 2001 through 2005. According to TVA, its peak load reduction impacts are to increase from 0.7 percent of peak load in fiscal year 2000 to 2 percent of peak load in fiscal year 2005.

The Energy Right Program Actually Increased Consumption

TVA attributes 74 percent of the energy savings for the fiscal year period 1996-2000 to its Energy Right Program. This program offers incentives to encourage contractors, developers, and homeowners to install energy-efficient electric appliances, such as heat pumps and water heaters. (TVA attributes the remaining 26 percent to a direct load control program, discussed below.) The Energy Right Program includes components for new homes, manufactured homes, heat pumps in existing homes, and self-audits by residential customers. (See fig. 6.)

Figure 6: TVA's Peak Load Reductions from Demand-Side Management Programs, Fiscal Years 1996-2000



Source: TVA.

The Energy Right Program, which has the greatest number of participants among TVA's demand-side management programs, is designed to reduce residential customers' consumption both year-round and during peak-demand times through increases in energy efficiency. In fiscal year 2000, 37,182 residential customers became participants in the program, a substantial increase from the 15,481 residential customers who became participants in fiscal year 1996. TVA anticipates that an additional 58,900 new participants will join the program in fiscal year 2005.

Similarly, TVA expects the program's impacts to increase by fiscal year 2005. The reduction in year-round consumption, which stood at 23,565 megawatt-hours in fiscal year 1996 and 54,129 megawatt-hours in fiscal year 2000, is expected to reach 83,726 megawatt-hours in fiscal year 2005. Also, the reduction in peak load demand, which was 19 megawatts in fiscal year 1996 and 43 megawatts in fiscal year 2000, is expected to reach 62 megawatts in fiscal year 2005.

Table 1: Peak Load Reductions from TVA's Demand-Side Management Programs, Fiscal Years 2000 and 2005

Name of program	Customers targeted	Number of participants, fiscal year 2000 [a]	Estimated savings (in megawatts)	
			2000	2005
Cycle and Save Program	Residential and small commercial	57,913	54	58
Energy Right Program	Residential	37,182	43	62
Interruptible Power Program	Commercial and industrial	396	[b]	[b]
Load Buyback Initiative	Large commercial and industrial	[c]	[c]	37
Total			**97**	**157**

[a] For the Energy Right Program components, this is the number of new participants enrolled in fiscal year 2000.

[b] TVA did not estimate the benefits of this program.

[c] The program did not exist in 2000.

Source: TVA.

According to TVA's most recent estimate, the program's overall effect on peak demand varied by season. For example, in 1996, the program resulted in an annual decrease of 19.4 megawatts in peak summer demand and an annual increase of 31.3 megawatts in winter demand, by providing incentives to developers and others to install appliances powered by electricity rather than natural gas or another energy source. According to TVA, such programs help improve the overall efficiency of its system and ultimately result in lower costs to consumers.

TVA Limited the Scope of Its Load-Control Program

TVA's Cycle and Save program allows TVA to turn off certain appliances in participating households for short periods when demand is high. TVA estimates that its Cycle and Save Program for residential customers accounted for about 26 percent of the savings realized from fiscal year 1996 through 2000. On an annual basis, the program's savings outpaced those attributed to the Energy Right Program. However, because the Cycle and Save Program's benefits are not cumulative, the Energy Right Program accounted for 74 percent of the cumulative savings.

TVA reduced the incentives it offered distributors to participate in the Cycle and Save Program and later restricted the number of distributors that may participate in the program. According to the program manager, TVA determined that the Cycle and Save Program was not cost-effective and allowed it to decline over time. As a result, peak-time consumption was presumably higher than it would have been if TVA had not taken these actions. For example,

- TVA shifted to the distributors the cost of purchasing, installing, and maintaining the switches that allow certain appliances to be cycled-off. While TVA initially paid for all switches installed on appliances, including air conditioners, standard water heaters, and storage water heaters, it currently pays for the switches only on storage water heaters. TVA pays only for these switches because storage water heaters are cycled-off for a longer period of time than air conditioners and standard water heaters, thereby providing enough peak load savings to justify their costs.
- Between 1992 and 1998, TVA reduced the amount of the monthly credit provided to participating distributors. It reduced the credit for storage water heaters from $5.70 to $5.50; for standard water heaters from $5.25 to $4.75; and for air conditioners and heat pumps from $1.40 to $1.15 (dollar figures not adjusted for inflation).
- TVA estimates that 30 percent of the radio-controlled switches that allow the water heaters or air conditioners to be cycled off are inoperable. TVA currently allows only 14 of its 158 distributors to participate in the program. According to the TVA program manager, as many as 30 distributors participated in the mid-1980s, but this number declined significantly after TVA eliminated incentives for distributors to participate in the program. The manager further noted that despite TVA's changes in the program, several non-participating TVA distributors continue to express interest in participating in the program.

TVA Reports No Energy Savings for Its Rate-Schedule Program

TVA offers rate discounts to its commercial and industrial customers who give TVA permission to interrupt their power during periods of peak demand (called "interruptible power contracts"). According to TVA, 51 of

the 62 large federal and industrial customers it serves directly have such contracts, as do 345 of its distributor-served commercial and industrial customers. TVA estimates that these contracts give it the ability to curtail up to 1,800 megawatts of power at times of peak demand. However, TVA seldom uses this tool. Between 1996 and 2000 TVA curtailed power under these contracts on only three occasions, and did not measure the savings it accrued. Moreover, according to TVA, the customers enrolled in these programs may reduce their consumption by 300 or more megawatts in response to price increases.

TVA Projects Bigger Demand-Side Management Savings in the Future

TVA projects that its demand-side management programs will save nearly twice as much in the fiscal year 2001 through 2005 period as they did in the previous 5-fiscal year period. Specifically, it projects cumulative savings of 396 megawatts through fiscal year 2005, in contrast to the 204 megawatts saved through fiscal year 2000. The higher level of savings stems from several factors: increased participation in its long-standing programs, and the introduction of a new "buyback" program for large commercial and industrial customers in June 2001. Specifically, this program allows TVA to buy power back from its large commercial and industrial customers whenever it is economical for these customers to curtail their power usage or when they can generate power from on-site sources. TVA expects that the program will reduce peak demand by an average of about 27 megawatts annually between fiscal years 2001 and 2005, or 133 megawatts overall for the fiscal year 2001 through 2005 period.

In October 2001, TVA began a study of its demand-side programs, which it expects to complete in early 2002. According to the TVA project manager, the study's goal is to identify ways to increase cumulative savings to 500 megawatts by the end of fiscal year 2003—75 more megawatts than the current estimate of 425 megawatts for fiscal year 2003. The study will consider a range of options, including real-time pricing, rebates to consumers who purchase energy-efficient appliances (such as air conditioners and refrigerators), and incentives for industrial and commercial customers to install high-efficiency lighting.

Other Utilities More Aggressively Pursue Demand-Side Management Programs

Some comparable utilities have gone further than TVA in implementing demand-side management programs that are similar to TVA's programs and in operating other programs. In an effort to determine how other utilities are approaching demand-side management, we contacted four utilities with such programs:

- The Bonneville Power Administration, which sells wholesale electricity, primarily generated by hydropower, in Idaho, Oregon, Washington, and a portion of Montana;
- Florida Power and Light, a utility serving a large residential population in Florida;
- Georgia Power, which serves retail customers in Georgia; and
- Puget Sound Energy, which sells electricity to retail consumers in Washington state.

The utilities we selected serve different sections of the country and face differing regulatory environments. For example, Florida Power operates in a regulated environment and recovers expenses from an energy conservation cost recovery plan run by the Florida Public Service Commission. As compensation for demand-side management expenditures, Florida Power and Light requested reimbursement of more than $158 million from the Commission in 2000.

Energy Efficiency Programs

Unlike TVA, the Bonneville Power Administration—an agency of the U.S. Department of Energy—offers a credit program to wholesale power customers who take action to further conservation and renewable resource development in the region. Bonneville offers utilities and directly served customers a rate reduction of one-twentieth of a cent per kilowatt-hour to develop their own conservation and renewables programs.

Peak Load Reduction Programs

Like TVA, both Florida Power and Light and Georgia Power have load management programs for residential customers. Florida Power residential customers receive a bill credit if they allow the utility to switch off their air conditioners, hot water heaters, and pool pumps at peak times.[8] The utility estimates that about 657,000 (about 19 percent) of its residential customers participate in its load control program, as contrasted

[8]The bill credit is $12.50 for summer months (April through October), if the customer enrolls for all three options, and $8.50 for winter months.

with about 2 percent of TVA's residential customers. In addition, Florida Power has 14,285 businesses enrolled in a similar program for air conditioners. Florida Power and Light estimated that peak load savings from its program amounted to 941 megawatts in 2000. Similarly, Georgia Power operates a program that cycles off power to residential air conditioners. The program, begun in 1997, is projected to reduce peak demand by 44 megawatts in 2004.

Also, like TVA, Georgia Power has 500 megawatts of interruptible power available. Though interruptions are rare, Georgia Power uses an average of 350 megawatts when necessary. In the summer of 2000, it interrupted power for a total of 12 hours over 3 days.

Rate-Schedule Programs

Georgia Power and Puget Sound Energy have experience with time-of-use pricing programs—Georgia Power involves commercial and industrial customers, while Puget Sound Energy involves residential customers. Georgia Power started a real-time pricing program in 1992, and it has become the largest such program in the country, according to the Electric Power Research Institute. About 1,600 large commercial and industrial customers, or about 25 percent of such customers, participate in the program. In response to peak demands for power, Georgia Power can initiate a pricing "event." The company uses e-mail to notify participating customers, a day or an hour ahead of time, that their prices during the event will be based on the marginal cost of producing power.

During such an event, prices have two components: (1) a baseline charge and (2) either a marginal charge or credit, depending on how the customer's energy use varies from its historic energy use. In August 1999, when prices spiked to more than $1 per kilowatt-hour (15 times the average price),[9] customers reduced their demand by 800 megawatts. During typical peak events, customers reduce demand by an average of 300 megawatts.

During 2001, Puget Sound Energy piloted a time-of-use program for about 300,000 of its 1.4 million residential customers in order to get them to use less electricity at peak demand times. It established different rates for

[9]According to the Energy Information Administration, in Georgia in 1999, commercial customers paid an average of 6.67 cents per kilowatt-hour and industrial customers paid an average of 4.15 cents per kilowatt-hour.

4 time periods during the day—from a low of 6.5 cents per kilowatt-hour at night to 9 cents during the mid-morning and evening hours. Moreover, Puget Sound Energy's state-of-the-art automated meter reading system allowed its customers to log on to its website and track their energy consumption throughout the day. The utility found that the customers involved in the "informational pilot program" (billed on the standard rate but provided with consumption information via the internet), on average, shifted about 5 percent of their consumption from peak to off-peak hours. Preliminary results indicate that those actually being billed on the time-of-use rate reduced their overall consumption by 6 percent. Subject to state regulatory approval, Puget Sound Energy said it plans to introduce the program to all of its residential customers in 2002.

Bonneville Power has a demand exchange program for large industrial and commercial customers who are willing to curtail their consumption depending on electricity prices. Program participants are notified via the internet of hourly, 1-day-ahead, and 2-day-ahead prices that are associated with peak load events. Customers may respond, via computer, noting their willingness to curtail their use of power at the posted prices.

Conclusions

While TVA plans to substantially reduce its SO2 and NOx emissions by three means—installing control devices, using lower-sulfur coal, and relying largely on noncoal sources for additional capacity—it could reduce emissions even more by more aggressively pursuing an existing fourth option—demand-side management. However, TVA's demand-side management programs are generally limited in scope, and they contribute little to moderating future demand. As a result, to meet its customers' growing demand for power, TVA will need to generate more power itself, or purchase more power from others, which will likely produce more air emissions. In contrast, certain other utilities have realized greater savings from their demand-side management programs. TVA's recently commissioned study of opportunities to increase the short-term impact of its demand-side management programs may serve as a useful first step. However, TVA still needs to assess the potential contributions of demand-side management over a longer time horizon.

Recommendations for Executive Action

TVA should reevaluate the design of its current programs and evaluate opportunities for adopting proven ideas from other utilities. Accordingly, we are recommending that the TVA Chairman (1) evaluate the structure and effectiveness of its current programs; (2) review the longer-term

potential applicability of other programs to its power system; and (3), as appropriate, implement demand-side management practices.

Agency Comments

We provided a draft of this report to TVA for review and comment, and received a letter from the Interim Vice President for Governmental Relations (see app. III). He said that TVA was evaluating its own demand-side management programs, including identifying potential opportunities, researching programs offered by other utilities, and analyzing the cost effectiveness of potential programs, all of which are consistent with our recommendations. In addition, he provided technical comments, which we have incorporated in the report as appropriate.

Scope and Methodology

To determine TVA's plans for meeting future power demands for electricity while minimizing emissions of SO2 and NOx and to describe the scope and impact of TVA's demand-side management efforts, we interviewed officials from TVA and reviewed studies and other documents prepared by the Department of Energy's Energy Information Administration and TVA. In addition, we interviewed three TVA distributors that participate in TVA's demand-side management programs in order to hear their opinions on the programs' strengths and weaknesses. In addition, we contacted experts at five non-governmental organizations—the American Council for an Energy Efficient Economy, Edison Electric Institute, Electric Power Research Institute, Regulatory Assistance Project, and Southern Alliance for Clean Energy.

To describe the demand-side activities of other utilities, we contacted officials from, and reviewed studies and other documents prepared by, the Edison Electric Institute, the Electric Power Research Institute, and four utilities: the Bonneville Power Administration, Florida Power and Light, Georgia Power, and Puget Sound Energy. We selected these utilities for their geographic dispersion, diverse customers bases, and reputation for undertaking noteworthy demand-side management efforts. These utilities are not necessarily representative of other utilities in this country.

We conducted our review between July 2001 and February 2002 in accordance with generally accepted government auditing standards.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report for 14 days after the date of this letter. At that time, we will send copies of this report to the

Ranking Minority Member, Subcommittee on Legislative, House of Representatives Committee on Appropriations; Senator Fred Thompson; Representative Zach Wamp; the TVA Chairman; the EPA Administrator; and other interested parties. We will make copies available to others upon request.

Questions about this report should be directed to me or David Marwick at (202) 512-3841. Key contributors to this report were Richard A. Frankel, Timothy Minelli, and Richard Slade.

Sincerely yours,

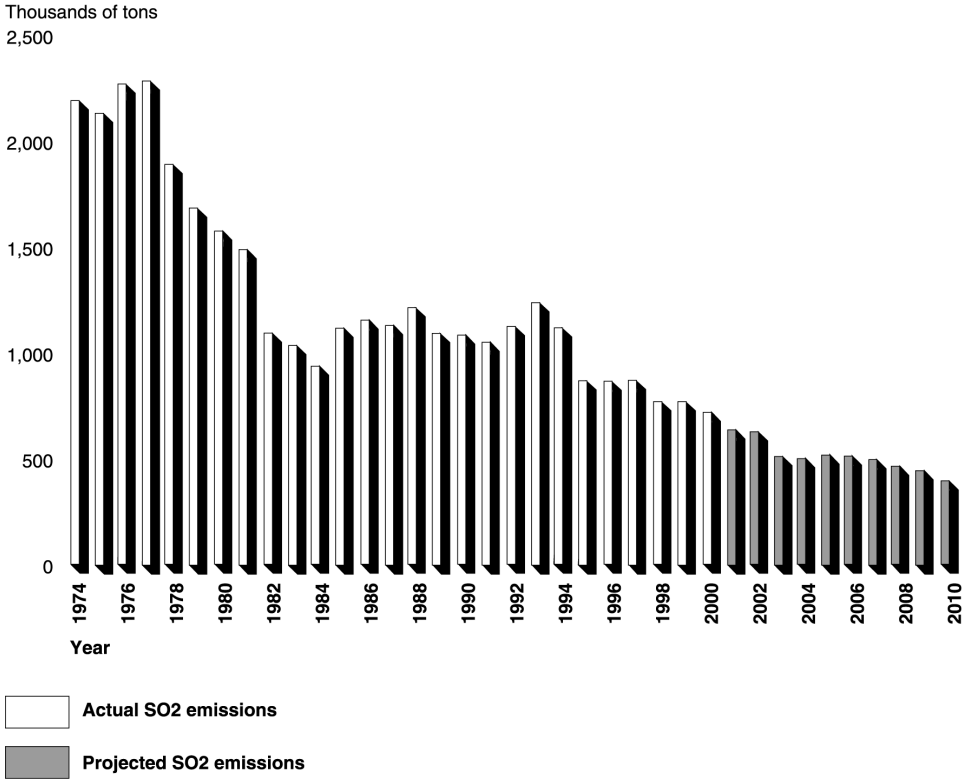
John B. Stephenson
Director, Natural Resources
and Environment

Appendix I: TVA's SO2 Emissions, 1974-2010

The planned reduction in TVA's SO2 emissions from 2001 to 2010 continues the trend over the previous quarter-century, as shown in figure 7. TVA's emissions dropped from 2,212,000 tons in 1974 to 727,000 tons in 2000, and are expected to drop to 406,000 tons in 2010. This represents an 82-percent decrease over the entire period.

TVA's two primary means for reducing SO2 emissions from its coal-burning plants are (1) installing scrubbers that remove sulfur from smokestack gases and (2) decreasing the sulfur content of the coal it burns to generate electricity.

Figure 7: TVA's SO2 Emissions at Coal-Fired Plants: Actual Emissions, 1974-2000, and Estimated Emissions, 2001-10



Source: TVA.

Between 1974 and 1995, when TVA reduced its annual emissions from 2,212,000 tons to 876,000 tons, there were notable decreases in 1978, 1982, 1984, and 1995. These decreases reflect the installation of scrubbers at TVA's two largest plants (Cumberland in Tennessee and Paradise in

Kentucky), as well as at Widow's Creek in Alabama, in those years. Between 1995 and 2000, TVA further reduced its annual emissions to 727,000 tons, without adding any more scrubbers, by switching to lower-sulfur coal. Over those 5 years, TVA lowered the average sulfur content of its coal purchases from 2.26 percent to 1.88 percent. This decrease of about 17 percent is roughly equal to the proportional decline of SO2 emissions during that period.

Between 2000 and 2010, TVA plans to use both strategies to further reduce its SO2 emissions. Through 2005, TVA plans to reduce its annual emissions to 525,000 tons, by continuing to switch to lower-sulfur coal. Beyond 2005, TVA plans to further reduce its emissions, by installing five scrubbers on 12 units at four coal-fired plants. This will increase to 60 percent the share of TVA's coal-fired capacity operating with scrubbers.

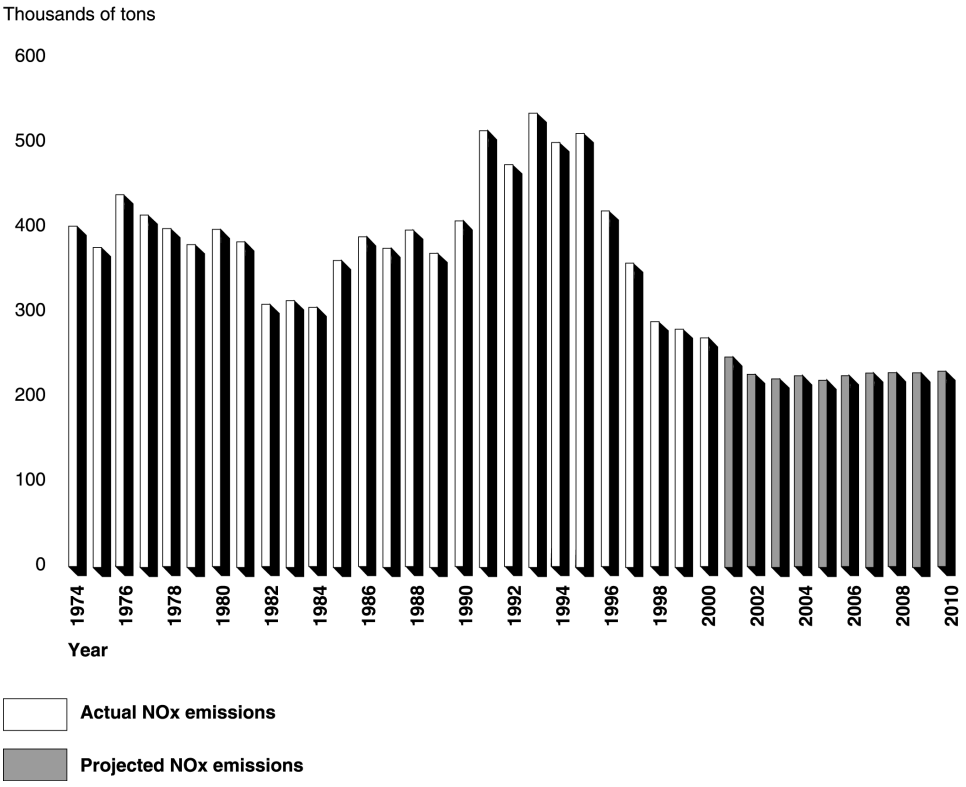
According to TVA, in 2001, TVA emitted SO2 at a rate of 1.18 pounds per million British thermal units of fuel energy. TVA expects the rate will decline to below 0.8 pounds per million units in 2010. This remains above the rate that plants considered new sources are required to meet, which is about 0.3 pounds per million British thermal units.

Appendix II: TVA's NOx Emissions, 1974-2010

TVA's planned reduction in NOx emissions at its coal plants from 2001 to 2010 continues the trend that began after 1995, when emissions reached 530,000 tons. (See fig. 8.) In that year, phase one of the Acid Rain Program (authorized by title IV of the Clean Air Act Amendments of 1990) started and TVA began modifying its coal plants to reduce their NOx emissions.

By 2000, when the program's second phase began, TVA's annual NOx emissions had fallen to 285,000 tons. In that year, TVA's first selective catalytic reduction system went into operation at its Paradise, Kentucky, coal plant. According to TVA, by spring 2005, it will have installed 18 selective catalytic reduction systems, or similar systems, on 25 generating units at 7 of its coal plants. TVA projects that, once these systems are installed, the NOx emissions from its coal plants will fall to 215,000 tons in 2005. NOx emissions shown in figure 8 reflect no additional controls beyond the 18 systems.

Figure 8: TVA's NOx Emissions at Coal-Fired Plants: Actual Emissions, 1974-2000, and Estimated Emissions, 2001-10



Source: TVA.

Appendix III: Comments from the Tennessee Valley Authority

Tennessee Valley Authority, One Massachusetts Avenue, NW, Suite 300, Washington, DC 20444-0001

Jimmy Johnston
Interim Vice President, Government Relations

February 21, 2002

Mr. John B. Stephenson
Director, Natural Resources and Environment
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Stephenson:

COMMENTS BY THE TENNESSEE VALLEY AUTHORITY (TVA) ON THE DRAFT BRIEFING REPORT, *AIR QUALITY - TVA PLANS TO REDUCE AIR EMISSIONS FURTHER, BUT COULD DO MORE TO REDUCE POWER DEMAND*

TVA appreciates the opportunity to comment on the subject report. As a public power provider and regional development agency, TVA is committed to balancing the interests of providing reliable, low cost power and improving the environmental performance of our operations. Knowing the responsibility inherent in being one of several public stewards of the Tennessee Valley's natural resources, TVA is continually researching and implementing the most cost effective means to improve our operations.

As your report mentions, current TVA programs project to dramatically reduce SO2 and NOx emissions from our plants while also doubling the amount of savings from demand side management programs by 2005. Additionally, TVA is currently evaluating our demand-side management programs in an effort to identify additional opportunities for savings. This process includes identifying potential demand-side management opportunities, researching programs offered by other utilities, and analyzing the cost effectiveness of potential programs. This effort along with almost $3 billion in emissions control spending are strong examples of TVA's commitment to improving air quality in the most efficient manner possible.

Enclosed are a number of other, more technical comments on the report.

Sincerely,

Jimmy Johnston

Enclosures

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