

Understanding How TVA Works



Part 5 in TVA's Business Education Series

How the TVA system works

**What happens behind the scenes
to make sure that reliable power
is delivered to TVA's customers?**

Before we plunge into this month's topic, let's review what's been covered in this series so far. The first edition gave you "The Big Picture." You learned that TVA is not just another government entity, it is a vibrant and functioning corporation. In the second edition, you learned what comes in and goes out of "The TVA Checkbook." Then you learned about the products and services TVA produces in "Adding Value to the Valley." Last month's insert discussed "Serving TVA's Customers."

This month, you are going to be taken on a behind-the-scenes tour to learn How the TVA System Works. In light of August's massive blackout in the Northeast, people are more interested than ever in learning about the electric system.

TVA's Systems Operation Center is sometimes considered TVA's command central. It is where TVA's more than 30,000 megawatts of generation are dispatched to meet the needs of 62 directly served industries and 158 distributors. So without further delay, flip the page and go where few have gone before.

It's all about supply and demand.

When you walk into the room, the first thing you think is “These folks look just like the utility industry’s equivalent of air-traffic controllers.”

Multiple rows of people working on computers talk excitedly back and forth and on the phone. There’s a real buzz in the air. They all face a giant map at the front of the room. With more than 35,000 indicators and lights, it may well be the largest such display in the world. It’s called the “Full-System Map Board,” and it depicts the transmission system for the entire Tennessee Valley. This is where it all comes together 24-7, 365 days a year. This is TVA’s System Operations Center.

So, what is the purpose of the SOC? It’s all about reliably “keeping the lights on.” The best way to explain how this is done is in the terms of a basic economic theory — power supply and consumer demand.



TVA’s power-generation and transmission systems must be in balance and under control at all times. Seems easy enough until you consider that demand changes every second. How do you make sure you have just enough power, and not too much or too little?

Take a moment to look back at the third installment of this series, where we described TVA’s power-generation sources. Since electric power cannot be stored, the right amount needed must be generated and transmitted every second. And keep in mind that the forecast error rate has to be kept to 1-2 percent or the system will be thrown off balance. This means some of TVA’s generating facilities provide baseload power, and some generating facilities provide power for peak demand periods. This must be carefully orchestrated because the cost of starting and stopping generation is very costly. TVA is very fortunate to have diverse generating capabilities that provide flexibility in ensuring a balance of supply and demand.

There are three basic ways the SOC team balances supply and demand — planning, monitoring and predicting. Detailed plans are developed for all generation and transmission assets. Then the current, real-time situation is constantly monitored. What is the current temperature? Are any lines down? Are any generating plants unavailable? Is TVA generating/purchasing enough electricity? Future use is predicted. An onsite meteorologist looks at weather conditions from 10 minutes out to 10 days out. A one-degree change in temperature during the summer is equal to about 450 megawatts — enough to power a city such as Huntsville, Ala.

Lastly, all these factors and more must be taken into account so the power supply and consumer demand can be managed accurately. That’s why the SOC team members are all in the same room, so they can work together and quickly react to situations. TVA’s 99.999-percent reliability rate attests to how well this team works with the generating plants and Transmission/Power Supply field forces to keep the lights on.



The people who move the power.

The heart and soul of the SOC are the highly trained men and women who work around the clock to keep the electricity on.

This diverse team of engineers and operators use real-time information and quick responses to make sure TVA power is delivered reliably and economically.

They constantly monitor and evaluate TVA’s generating assets, the weather, historical data and many other factors to manage power availability and transmission reliability to meet the needs of more than 8.3 million consumers.

Their considerable responsibilities include everything from determining the most efficient source of power at any given time to managing peak-demand days to ensuring a continuous supply of electricity. At the same time, the transmission grid must be monitored to ensure lines and equipment are not overloaded. Clearances must be issued — about 25,000 per year — so electricians, linemen and field-test engineers can perform their work safely. Throw in the frequent challenges — large-unit emergency trips, tornados, ice storms, etc. — and the situation can become very demanding.

SOC operators share the responsibility for ensuring the safe and reliable operation of the entire Eastern Power Grid. Using the complex information they gather, system operators adjust the mix of power generation to meet constantly changing customer demands for electricity.

Lights out.

On Aug. 14, the Northeastern United States and Canada experienced the worst power blackout in North American history.

As many as 50 million people were without power in Massachusetts, Michigan, New Jersey, New York, Ohio, Connecticut and Ontario. The cost of the blackout in New York City alone has been estimated to be as much as \$1 billion.

TVA is part of the Eastern Power Grid that runs from Canada to Key West. All of the transmission systems in between are linked, and problems anywhere on the grid can affect systems hundreds of miles away. Whenever there is a sudden loss of a large generating unit or a major transmission-line outage, the system must immediately be assessed and stabilized or the results can be catastrophic.

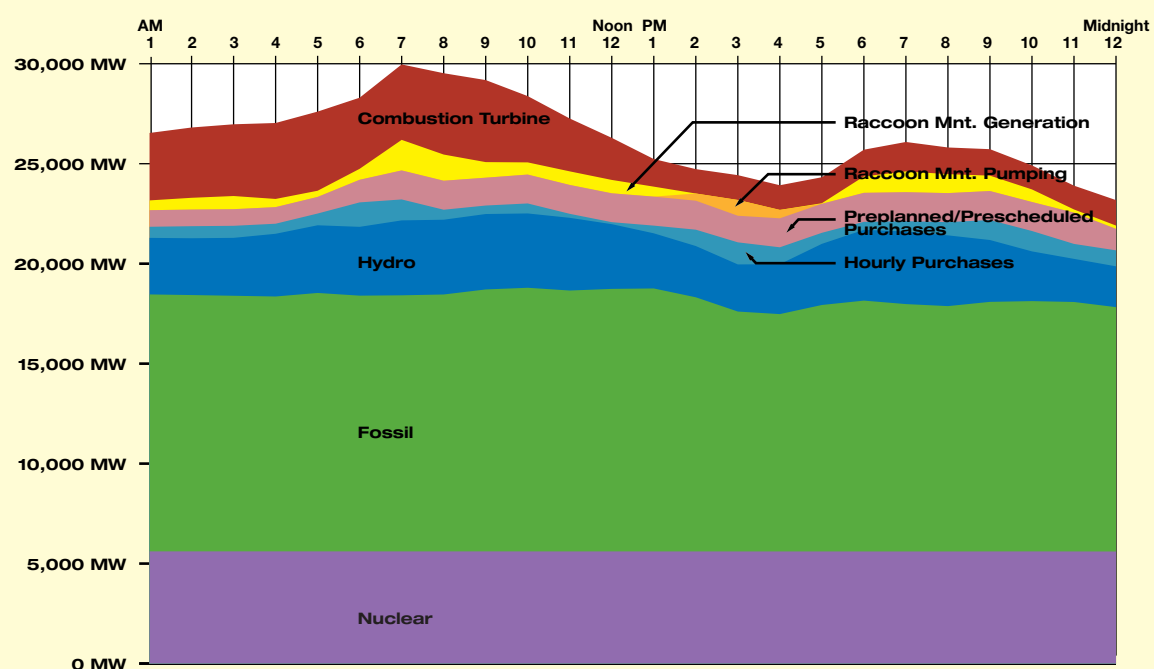
So, could a blackout happen at TVA? We never say never, but TVA does many things to make sure it doesn't happen in the Tennessee Valley. Over the past seven years, TVA has built 986 miles of new transmission line and 204 new power-delivery points to strengthen the grid. Assets also have been added to TVA's already strong generation fleet to ensure power is there when it is needed. Through detailed planning, reliability-centered maintenance and excellence in operations, TVA was able to balance power generation and reliably manage transmission even under the taxing situation of Aug. 14.

Another tool in balancing supply and demand.

The SOC team must constantly balance power supply and consumer demand.

Supported by Bulk Power Trading and other TVA staffs, team members do this by evaluating the current situation and determining which source of power, or combination of sources, makes the most economical sense to meet the consumer demand at that moment.

On Jan. 24, 2003, demand for TVA power hit an all time high. The chart below shows the sources of power — hour by hour.



Getting the power where it's going.

Producing power and balancing the consumer demands and power supply are just part of the story.

Customers' needs would not be met if TVA couldn't get the power to them. The power is transmitted over 17,000 miles of transmission line controlled by the SOC. TVA's Transmission Operations & Maintenance organization maximizes the availability of TVA's transmission system for the safe, reliable and efficient delivery of power to TVA's customers.

This includes maintenance of transmission lines and structures, substations, rights of way and transmission-communications equipment. This also includes providing primary transmission connections to the customer, overseeing day-to-day operations, providing emergency response and planning for future transmission needs. The field work is accomplished by 27 line crews and 27 electrician crews out in the field every day to ensure the reliability of the TVA system. The operators in the SOC are in constant communication with the TOM employees and distributor customer personnel to coordinate maintenance and repair activities on the transmission system.

In addition to TVA's generating capacities, the bulk-power-trading market is a key tool in ensuring the balance. When TVA has surplus power, the BPT organization can sell that power to certain neighboring utilities as allowed by the TVA Act. When TVA needs power, BPT may buy from the bulk-power market.

BPT has enabling agreements with many suppliers, and depending on the economics, BPT may purchase from any of them for the TVA system. Such suppliers include IOUs (Investor-Owned Utilities) such as AEP, Southern and Entergy, as well as IPPs (Independent Power Producers). Because market prices often fluctuate from hour to hour, BPT must stay abreast of these conditions, as well as the changing system needs.

BPT continues to actively trade in the hourly, daily and monthly markets when TVA system economics and market opportunities match. This flexibility helps support TVA in its goal for affordable, reliable power. Due to increased consumer demand and the ever-changing economics of the system, BPT is constantly engaged in seeking out arrangements that will benefit TVA's bottom line.

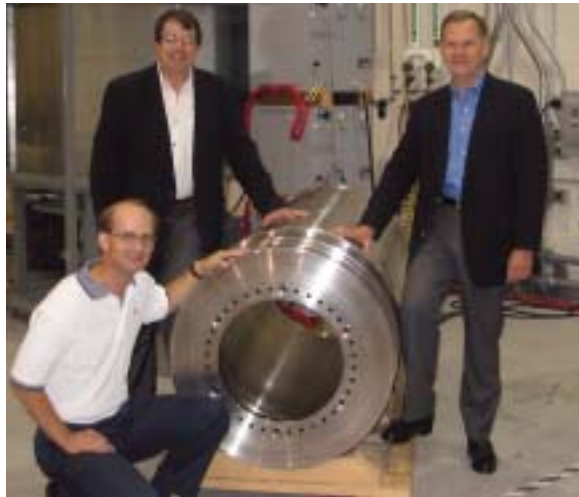
What is TVA doing to prepare for the future?

TVA has provided affordable, reliable power for the past 70-plus years.

We at TVA have proven that we can do that and do it well. We can be proud that TVA has long been a leader, developing North America's first 500-kilovolt transmission lines and the first large-scale flexible alternating-current device.

But what about the future? As strong as TVA's system is, the recent blackout shows that "the grid" is increasingly vulnerable to growing demands. TVA is on the leading edge of implementing technologies to boost the reliability and efficiency of its power system. Here are a few of these "cutting edge" initiatives:

- Last year the TVA Regional Operations Center was completed and staffed. This state-of-the-art operational facility houses personnel who work with surrounding utilities to ensure bulk-grid reliability and provide transmission service to companies transporting power across TVA's grid. It also serves as a fully functional 24-7 back-up to the SOC.
- Last April, TVA launched the Power System Optimization Project. PSOP will capture accurate, real-time data on generation, transmission and customer operations. It also will improve the communications-system performance to make the data available on a real-time basis. This will allow TVA to monitor the system in real time, allowing for more responsive control.



Michael Ingram, Program Manager in Energy Research & Technology Advancements, Terry Boston, Executive Vice President of Transmission/Power Supply, and Greg Yurek, CEO of American Superconductor Corp., are shown here with the SuperVAR torque tube. This tube protects the superconducting coils as they spin at a rate of 1,800 RPM.

- In November, TVA will dedicate the first prototype SuperVAR unit in Gallatin, Tenn. SuperVAR technology is designed to increase transmission capacity through existing power lines while providing options for voltage stability and support.
- TVA is working with Oak Ridge National Laboratory and other partners on the Powerline Conductor Accelerated Testing project designed to reduce power outages caused by sagging power lines. Successful testing of these advanced transmission conductors will help

relieve congestion by allowing more electrical current to flow across existing power lines.

- Two development activities are progressing toward the production of a transmission ultracapacitor prototype, an advanced power-flow device that controls power-system voltage and manages power swings. Two research endeavors — advanced power electronics and fast-response energy storage — were integrated in the development of this technology.

These are just a few of the projects that show how TVA is taking a measured and flexible approach to industry changes with a strong emphasis on protecting reliability and serving the power-supply needs of the seven-state TVA region.

Diamonds are a grid's best friend.

TVA and its partners, along with Auburn and Vanderbilt universities, are developing innovative transmission technologies that use diamond material instead of silicon. Diamond-emitter devices, used in place of silicon-semiconductors, produce revolutionary improvements in power flow and power-switching performance. These high-speed, high-quality diamond materials will help transform today's transmission grid into a digital-quality electricity superhighway.

So, what does this mean for you?

As you have learned throughout the Business Education series, TVA is a very large and complex business. This month you learned about the System Operations Center and how it is at the heart of everything that goes on at TVA. By learning more about the inner workings of the system, you can better understand the part you play in TVA's success. All employees of TVA are united by the common goal of supplying the Tennessee Valley with affordable reliable energy. Your efforts are important, because each individual contributes to the success of the company. TVA's Winning Performance Strategic Objectives are a way of measuring the quality of performance and providing feedback that will lead to ways to improve. By working to meet these objectives, you will be doing your part.

You can view this special insert on TVA's internal Web site.

For more about TVA operations and facilities, go to www.tva.com.



What You Can Do

- Remember that you play on the bigger TVA team and that you are important to TVA's success.
- Learn everything you can about TVA and how it works.
- Become a knowledgeable advocate and ambassador for TVA.
- Make sure you do your job to the best of your ability.
- Look for ways to continuously improve your performance.