

# After Action Report

## Winter Storm Elliott



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# Preface

Every day, businesses are confronted with challenges that test the operational abilities of an organization and the fortitude of all involved. One of the hallmarks of successful organizations is the ability to learn from these events ... to adapt and improve.

At TVA, we are a learning organization ... committed to continuous improvement.

Reliable and secure energy is essential for families and businesses. It's what you expect and deserve. At TVA, we take great pride in providing the 10 million people of the Tennessee Valley region with reliable energy 24/7.

We fell short of your expectations during Winter Storm Elliott. While we planned and prepared for this event, the storm's speed and intensity exceeded our efforts.

Immediately following the storm, we proactively initiated an **After-Action Technical Team** to conduct a thorough review of what happened and why. This team included subject matter experts from areas across our organization. We also asked employees to provide us with immediate recommendations based on the challenges they encountered during the storm.

Working with our 153 local power companies (LPCs) across the seven-state region we serve, we formed a **Customer Engagement Team** to provide ongoing feedback to our review process. And we engaged a **Blue Ribbon Commission** to provide independent perspectives and insights.

We took these steps – first and foremost – because it's the right thing to do. As a learning organization, we are committed to understanding and sharing lessons learned and – more importantly – implementing actions to ensure we are better prepared to manage significant events in the future.

This report highlights the findings from the events surrounding Winter Storm Elliott, recommendations for improvement, and actions associated with each recommendation.

The strength and resilience of our system was tested during Winter Storm Elliott, and we will learn, adapt, and improve.

It's a privilege to serve you.

**Don Moul**  
Executive Vice President  
Chief Operating Officer

**Bob Dalrymple**  
Senior Vice President  
Resource Management & Operations Services



# TVA Background

Nine decades ago, TVA was created with a clear mission to benefit the public good. TVA was established with the innovative concept of managing the vast resources of the Tennessee Valley as an integrated system across jurisdictional boundaries and to help lift the seven-state Tennessee Valley region from the depths of the Great Depression.

Since day one, a hallmark of TVA has been innovation, as we built dams to control flooding and constructed transmission infrastructure to bring the first electric lights to rural communities and farms.

TVA's unique, longstanding mission focuses on:

- **Energy:** affordable, reliable, resilient and clean
- **Environmental Stewardship:** protecting and preserving public lands and water
- **Economic Development:** attracting investment and creating jobs

Today, TVA is the largest public power provider in the United States and is one of the nation's largest electricity generators. TVA supplies the energy that approximately 10 million people and over 750,000 businesses across the Tennessee Valley region rely on every day.

TVA is not doing this alone. The strength of partnership cannot be overstated. We are leveraging expertise and support from customer partnerships, industry partnerships, and stakeholder groups to help forge a path forward for the region that benefits all.

Companies choose to locate to the Tennessee Valley region because of the affordable, reliable, resilient, and clean energy TVA and Local Power Companies (LPCs) provide, and we want to ensure we can continue to support those economic opportunities for our region. In FY 2022 TVA helped create 26,500 new jobs and retain 40,000 jobs.



ENERGY



ENVIRONMENTAL STEWARDSHIP

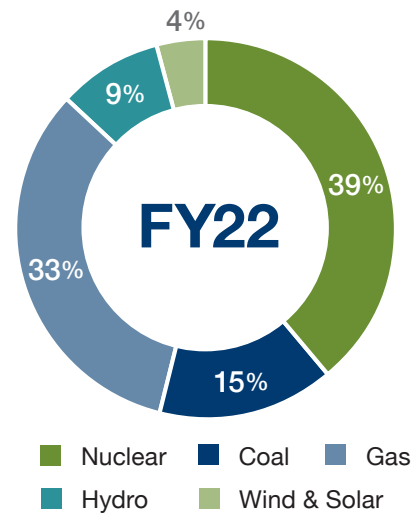


ECONOMIC DEVELOPMENT



## TVA Power System Background

TVA operates one of the nation's largest and most diverse energy systems, with more than half of our energy supply coming from carbon-free sources. TVA also owns the nation's third largest nuclear fleet, with a generating capacity of over 8,000 MW (or enough power for 4.5 million homes and businesses), that is the backbone of our clean generation portfolio. TVA has a total of 232 generating units, as well as power purchase agreements (PPAs) with power producers.



TVA, like all other power grid operators, must ensure that the supply of electricity matches demand for electricity at all times. Power systems and generating facilities are built and maintained in accordance with an established design basis, which incorporates criteria such as safety, functionality, reliability, environmental



impact, and regulatory compliance requirements, and ensures that the system can perform as intended under normal and abnormal circumstances at a reasonable cost to consumers.

To maintain reliability, power providers must always have more generating capacity available than required to meet peak demand. This additional generation, called “reserve capacity,” must be enough to cover uncertainties such as unplanned unit outages, severe weather events, unexpected changes in energy use, or undelivered power purchases. Weather and economic activity are significant drivers of demand, or load, and TVA plans its system to be able to meet the highest demands, or peaks, that occur in the summer and the winter months by three primary forecasts to predict those loads:

- **Long-Term forecast** determines electric needs up to 20 years into the future and identifies reserve margins for the summer and winter peaks that target industry best-practice levels of reliability, while minimizing the cost of reserves and reliability events to consumers. This view, provided in Integrated Resource Plans (IRPs), is used to inform the development of appropriate generation assets.
- A closer, **Mid-Term view** is developed each year in the fall for the winter and in the spring for the summer. The mid-term view primarily informs trading positions in the energy market. If TVA has excess generation, it can sell power and capacity to neighboring utilities. Conversely, if additional power and capacity are required, it can purchase its needs in the market. The mid-term forecast was developed and made available internally in November 2022 and was used to prepare for Winter Storm Elliott.
- The real-time operations staff uses the **10-Day Forecast** to determine immediate needs. This forecast influences purchases on the day-ahead market and the dispatch of generation assets.

TVA meets its customer load requirements through a mixture of TVA-owned generation as well as market purchases. TVA's current Integrated Resource Plan set planning margins at 17% above peak load requirements in the summer and 25% above requirements in the winter. TVA has more than 38,111 MW of generation capacity (owned and contracted) available. In order to balance cost and reliability, TVA's generating assets are designed to withstand a one in ten-year reliability event.

TVA's ability to reliably deliver electricity to our customers is executed by an operations function called the Balancing Authority (BA). Staffed 24/7, the BA operations desk is responsible for ensuring supply of electricity precisely matches the demand for electricity at all times. The BA has several complex systems that provide a forecast of energy consumption, a real time

view of energy being used, and a real time view of power plant production. The BA has several methods for balancing electricity supply with demand in the event there is not enough TVA power – buy power from other systems; request voluntary reductions from the public; require reductions from industrial customers participating in incentivized programs; require reductions from LPCs from their industrial, commercial and residential customers; and, as a last resort, reduce consumption directly from the bulk system level.

Finally, to support bulk energy system reliability and resilience in extreme conditions, TVA, Tennessee Valley Public Power Association, and local power companies maintain emergency load curtailment procedures designed to ensure the stability of the grid even in extreme events.



# Winter Storm Elliott Background

TVA's objective and that of our 153 local power company partners is to never interrupt power. That's what we plan and strive for every day. During Winter Storm Elliott, we fell short of that objective.

Winter Storm Elliott was a powerful storm that impacted most of the eastern continental United States, bringing heavy snowfall and high winds to the Midwest and Northeast and freezing rain and high winds to the South.

The December 2022 storm wreaked havoc across the nation, causing travel disruptions and power outages.

The National Weather Service referred to Winter Storm Elliott as a "once-in-a-generation storm," which brought record-breaking cold temperatures and high winds to our region and across the nation.

Winter Storm Elliott did not take TVA by surprise. TVA anticipated and prepared for this event, but the storm's speed and intensity exceeded forecasts and TVA's efforts.

## Key weather facts for the Tennessee Valley region during Winter Storm Elliott:

- TVA's system average temperature was 3F at 8 a.m. CDT on Friday, Dec. 23. This was the coldest system average temperature since Feb. 5, 1996.
- On Friday, Dec. 23, the morning lows were Nashville 1F, Memphis 1F, Huntsville 3F, Knoxville 4F, and Chattanooga 7F.
- The afternoon high was 11F for the system average, falling to 8F for most of Friday night and early Saturday, Dec. 24.
- There have not been back-to-back mornings with system temperature lows in the single digits since February 1996.



# What Happened

A month prior to the storm, TVA developed and shared the Mid-Term forecast with the Transmission, Nuclear, Power Operations, and Facilities Management teams to complete the cold weather readiness actions and winter readiness certification process. These certifications were used by generation leadership, planning and real-time operations to determine energy reserve positions and inform short-term trading needs.

In mid-December, TVA Operations employees began tracking Winter Storm Elliott, making initial observations a week before it impacted the Tennessee Valley region. Severe weather notifications were issued to internal emergency management employees regularly throughout the week leading up to the storm and multiple business units engaged in preparedness activities. TVA committed a significant amount of generation resources ahead of the event to meet predicted demand, and took additional measures such as:

- TVA's generation plants took extra steps to ensure readiness.
- TVA's External Relations team began outreach to customers and stakeholders.
- TVA Police & Emergency Management engaged with TVA business units to remind them of the possibility of agency-level emergency coordination based on storm impact.

On Wednesday, Dec. 21, 2022, the TVA Reliability Coordinator issued a Cold Weather Alert and a Conservative Operations Alert for the entire TVA system

starting Thursday, Dec. 22, 2022, at 8 a.m. CDT through Monday, Dec. 26, 2022, at 5 p.m. CDT.

The high winds, heavy rain, and cold temperatures of Winter Storm Elliott arrived in the TVA service territory on December 22. These conditions increased energy demand beyond what had been forecast, resulting in the highest 24-hour electricity demand supplied in TVA history on December 23 as the speed, intensity, scale and duration of Winter Storm Elliott exceeded the design basis for some of TVA's power plants. In total, 38 of TVA's 232 generating units were negatively impacted, mostly due to instrumentation that froze.

TVA employees worked around the clock to increase generation to meet the demand, including dispatching units that had previously not been in service and executing day-ahead, real-time purchases and emergency purchases.

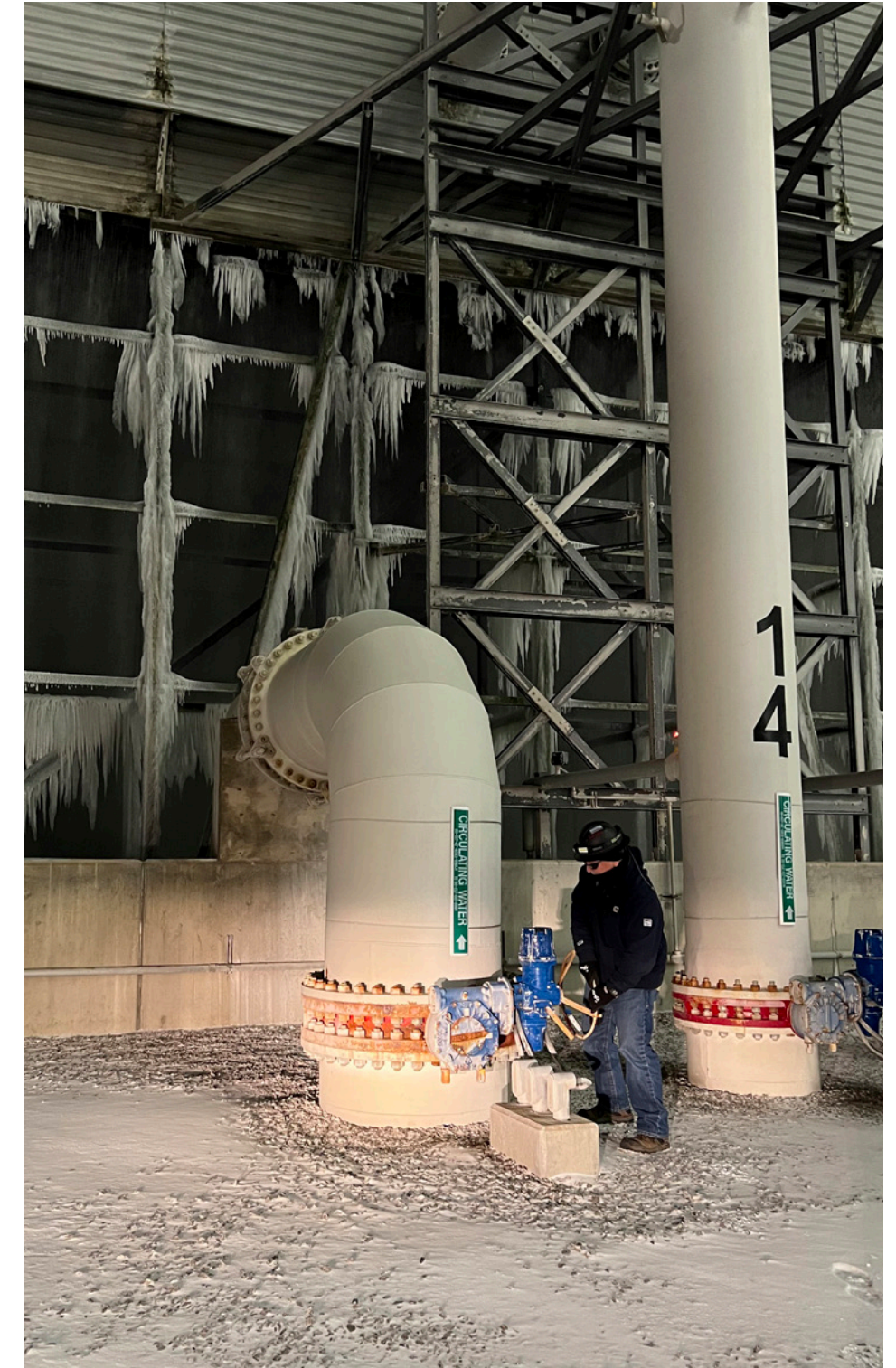
**TVA set multiple energy demand records during Winter Storm Elliott**

- **On Friday, Dec. 23, highest 24-hour electricity demand supplied in TVA history – 740 gigawatt-hours.**
- **Highest winter peak demand at 7 p.m. CDT on Friday, Dec. 23 – 33,425 megawatts (third-highest peak demand in TVA history).**
- **On Saturday, Dec. 24, at 1 a.m. CDT, highest weekend peak demand in TVA history – 31,756 megawatts**

In addition, TVA employees worked in extreme weather conditions to keep generating units online and restore units impacted during the storm. This included placing additional temporary structures, insulation, and heaters around equipment at impacted units. As a result of their efforts, 14 of the 38 generating units lost were recovered and returned to service within 48 hours.

TVA's nuclear and hydro assets were not affected by the extreme weather due to their plant design and operated without issue supporting energy demand during the event.

The storm also challenged neighboring utilities, limiting power availability, resulting in energy demand exceeding supply being generated and purchased. For the first time in TVA's 90-year history, TVA was forced to implement emergency procedures directing local power companies to reduce power demand that resulted in localized interruptions in order to keep the overall system stable.



## Event Timeline

### FRIDAY, DEC. 23, 2022

On Thursday, Dec. 22, the energy consumption forecast for the next day was 31,163 MW. To meet this demand, TVA would need about 90% of TVA's owned and contracted power production available.

On Friday, Dec. 23, between 1 a.m. – 6 a.m. CDT, temperatures were dropping rapidly as the BA monitored real time electricity consumption, which resulted in a significant increase in the projected demand (beyond what was forecast). To meet that demand, the BA needed about 97% of TVA's available owned and contracted power.

The rapid drop in temperature and other weather-related conditions also caused freezing issues at some power generating facilities, which resulted in the loss of approximately 20% of the available energy production. As a result, TVA needed about 17% more power than was available.

To maintain system stability and address the deficit, the BA acquired 3% market power, called on industrial customers who participate in interruptibles programs interruptibles programs to reduce demand, resulting in 5% reduction in consumption, and finally called on LPCs to reduce their load by 5%. After a little more than two hours, several affected power plants had recovered and returned to service and the BA ended the call for LPCs to reduce consumption.

#### SPECIFICS:

**At 4:30 a.m. CDT, demand for power exceeded the forecast by nearly 1,500 MW while TVA lost generation from multiple units (coal, gas, and independent power producers).**

**At 4:48 a.m. CDT, TVA called on industries and interruptible contracts to reduce energy demand, resulting in a reduction of demand by 1,612 MW (approximately 5% of system demand).**

**By 9:00 a.m. CDT, TVA had lost 6,705 MW of generation from coal, combined cycle gas, and independent power producers.**

**At 9:31 a.m. CDT, TVA initiated emergency procedures, directing 153 local power companies to reduce energy demand by 5%.**

**At 11:43 a.m. CDT, 2 hours and 12 minutes later – emergency procedures to reduce energy demand were lifted. Energy demand had been reduced by approximately 2,900 MW.**



### SATURDAY, DEC. 24

Following the peak electricity demand on Friday, Dec. 23, the BA began preparing for Saturday, Dec. 24. Nineteen percent of the available TVA owned and contracted power production remained out of service due to the freezing issues, and industrial customer consumption remained reduced by 5%. The forecast of energy consumption projected a need for 100% of the available TVA owned and contracted power plus an extra 6%.

The BA acquired 20% market power to cover the forecast and provide some contingency. Early in the morning of Saturday, Dec. 24, off-system purchases were cut off by other power systems because of emergency conditions on their own systems. TVA was forced to direct local power companies to reduce power consumption by 5% and then by 10%.

Five and a half hours later, the BA ended the call for LPCs to reduce consumption.

#### SPECIFICS:

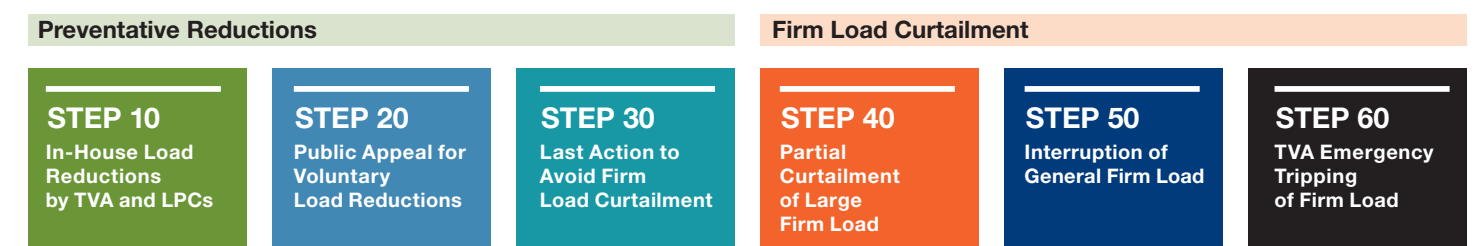
**At 4:51 a.m. CDT, because of continuing high energy demand and generation challenges, TVA directed local power companies to reduce energy demand by 5%.**

**At 5:12 a.m. CDT, this was increased to 10%. TVA also instructed its industrial customers and direct serve customers to reduce demand.**

**At 10:30 a.m. CDT – 5 hours and 39 minutes later – emergency procedures to reduce energy demand were lifted. Energy demand had been reduced by approximately 4,800 MW.**

Winter Storm Elliott was challenging, not only to TVA but to all the local power companies in the Valley region as well as utilities around the eastern United States. Because of the active participation and collaboration of many, including TVA, industrial customers, and residents, as well as decisive and deliberate actions by 153 local power companies across seven states, the grid remained stable and more serious consequences were avoided.

Figure 1 – TVA's Emergency Load Curtailment Program (ELCP)





Immediately following Winter Storm Elliott, TVA asked employees to capture lessons learned. More than 250 actions were captured and completed by the end of January.

These actions included strengthening and increasing the operational resilience at TVA's generating facilities, placing more robust enclosures at generating facilities, and enhancing insulation around instrumentation.

In addition, TVA is developing design modification plans for impacted generating units – to address both winter and summer peaks.

Emergency Management Processes and Procedures have also been evaluated and updated to improve internal coordination, communication, and preparedness. These updates are designed to clarify triggering events and better define roles and responsibilities.

Finally, processes for communicating with customers and key stakeholders are being updated to ensure TVA provides clear, consistent, and actionable information to all stakeholders.

Figure 2 – Dec. 22 Plan to Dec. 23 Peak Hour 9 a.m.

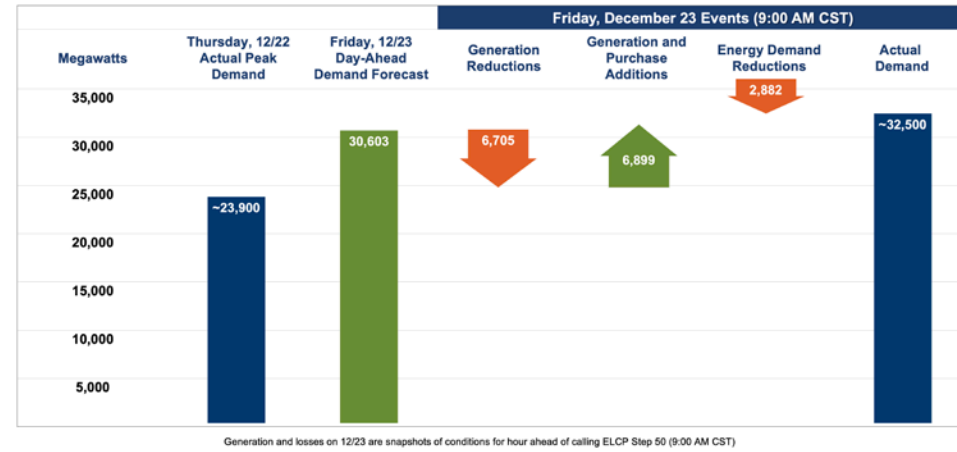
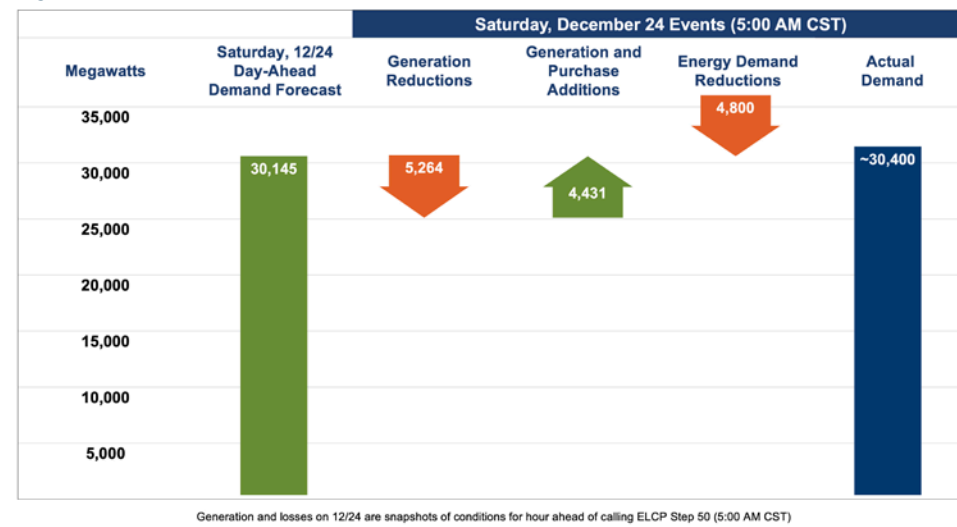


Figure 3: Dec 23 Plan to Dec 24 Peak

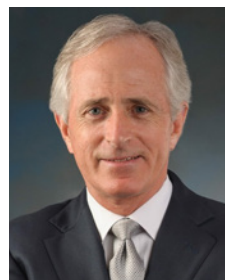


# What We Learned

Following Winter Storm Elliott, TVA immediately took steps to understand what happened and why and to draw lessons from the event through initiating a formal After-Action Technical Review. As part of this effort, TVA engaged industry experts and customers for input and feedback, incorporated independent oversight and expertise, and committed to share findings and progress as part of TVA's commitment to transparency.

TVA's After-Action Reviews included:

**Blue Ribbon Commission** – A panel of experts charged with the comprehensive review of actions taken before and after Winter Storm Elliott to provide independent perspectives to TVA leadership.



**Bob Corker,**  
former U.S.  
Senator



**Joy Ditto,**  
former President  
of American Public  
Power Association  
(APPA)



**Mike Howard,**  
retired CEO of  
the Electric Power  
Research Institute  
(EPRI)

**The After-Action Technical Team** – A team of internal experts from across multiple disciplines charged with examining TVA's preparation for and response to Winter Storm Elliott.

**Customer Engagement Team** – A team engaging with key customer leaders to gather input and feedback related to TVA actions taken before, during and after Winter Storm Elliott. Members include:

- **Doug Peters**, Tennessee Valley Public Power Association
- **Rob Hoskins**, Tennessee Valley Industrial Committee
- **John Bowers**, Pickwick Electric Cooperative (TVPPA Operations Coordination Advisory Group Chair)
- **David Wade**, EPB of Chattanooga
- **Doug McGowen** and **Alonzo Weaver**, Memphis Light, Gas and Water
- **Alan Gates**, Pennyrite Rural Electric Cooperative
- **Marlin Williams**, North East Mississippi Electric Power Association (TVPPA Communications Advisory Group Chair)
- **Teresa Broyles-Aplin**, Nashville Electric Service
- **Keith Carnahan**, Meriwether Lewis Electric Cooperative
- **Steve Hargrove**, Sheffield City Utilities Department (TVPPA Government Relations Advisory Group Chair)
- **Dave Cross**, Plateau Electric Cooperative
- **Jason Griggs**, Milan Utilities

*TVA has taken this process seriously and has been responsive to the questions and concerns of our respective Team. We believe that TVA is better prepared to address extreme weather events going forward and look forward to seeing more of these recommendations implemented to ensure we continue to get better at serving our customers together.*

– Customer Engagement Team

The review looked at five main categories or activities across the agency and the response of each to the storm:

### Energy Supply

- Like most utilities, TVA has a generation plan to meet customer load requirements through a mixture of TVA-owned generation as well as market purchases. In the event TVA were to experience higher-than-forecast demand, TVA could make up for that shortfall by buying energy and capacity from the energy markets.
- In addition, prior to the winter and summer seasons, each generating plant must certify that it has completed the necessary checks and preventive maintenance activities to support cold or hot weather operations. Nuclear plants have a similar process for their own certification.

### Real Time Load Forecasting and Operations

- While long- and mid-term forecasting as well as real-time load forecasting are instrumental in planning for how to meet a forecasted demand at any given time, decisions may need to be made in real-time to ensure TVA can meet demand, including calling on agreements with interruptible contracts and as well as other partnerships as needed.

### Emergency Protocols

- TVA, Tennessee Valley Public Power Association, and local power companies maintain emergency load curtailment procedures designed to ensure the stability of the grid even in extreme events. In addition, several TVA business units may implement Emergency Operations Centers (EOCs) to align key personnel to support a specific event. Depending on the magnitude of the event, TVA's enterprise leadership team also may direct the activation of the Agency Coordination Center.

### Customer and Stakeholder Engagement

- Communication during an emergency event is critical – both internally across the agency and externally to customers, stakeholders, and the general public. The External Relations Regional Model is designed to facilitate timely conversations with customers and stakeholders while TVA Communications is responsible for sharing information with the general public.

### Transmission

- TVA manages one of the largest transmission systems in North America with 16,400 miles of line – enough to span the United States six times over – providing the critical link that connects power from our generating plants through a network of 153 local power providers. Teams maintain the transmission system as well as balance the flow of power over that system with a focus on delivering power reliably where and when it's needed, regardless of fluctuations in demand or weather.

A team was formed for each category to conduct a deep-dive into what happened, how TVA responded, and how TVA can improve in the future. Specifically, each team determined the specific events, or drivers, that led to load reduction during Winter Storm Elliott; considered improvement opportunities to support an enhanced response to future hazards; and documented strengths, which include actions taken that had positive outcomes and should be evaluated for future events. Based on the teams' findings, they also determined recommendations for potential changes to the approach or execution of TVA's strategy.

The severity, duration and scale of Winter Storm Elliott resulted in dramatic increases in energy demand, decreased availability of TVA owned and contracted electricity supply, as well as decreases in imported electricity from neighboring markets. In order to maintain grid stability, this required TVA to curtail load to maintain grid stability.

## Drivers

The teams identified two drivers that had direct ties to the reduction of load during Winter Storm Elliott:

- Rain followed by extreme cold weather and wind created an environment that was beyond design basis of TVA generating sites, causing some units to trip offline causing a generation deficiency
- Due to the regional nature of the weather event, energy market purchases were curtailed, contributing to the generation deficiency

In addition to direct drivers of the event, the teams identified improvement opportunities in each category and what TVA did well in each category.

## Improvement Opportunities

TVA recognizes the importance of reviewing the actions taken during Winter Storm Elliott to identify improvement opportunities and address those areas. Several opportunities were identified across the categories:

- The importance of accurate forecasting to utilities can't be overstated, and in this instance, TVA's operational and real-time industry load forecasting tools did not accurately predict the load or the potential risks experienced during Winter Storm Elliott.
- While no gas generation units tripped offline because of gas pressure issues from the interstate pipelines, the gas fleet identified opportunities for improved communication across the fleet and TVA, to enhance coordination and visibility related to gas supply, pressure alignment and troubleshooting.
- The flow of information, both internally across the organization and externally with customers, stakeholders, and the public, was not timely or fully effective, which resulted in inconsistent messaging and lack of situational awareness and expectations, and slow internal coordinations, approvals and stakeholder responses.
- Slow internal coordination and approvals resulted in delayed information-sharing, social media updates, and responses to customers.
- There are opportunities for better coordination and implementation of emergency procedures and protocols across the agency.

## Strengths

While TVA found itself for the first time in its 90-year history directing local power companies to reduce their load, with many executing rolling outages to meet the request, several areas within TVA did perform well and should be considered strengths.

- Employees at the sites stayed focused on safety, even during very challenging weather conditions, and successfully performed their duties without incident throughout the storm.
- The execution of the Emergency Load Curtailment Program (ELCP) itself worked well. TVA's Transmission and Operations center executed the ELCP as designed and local power companies responded quickly when called upon, supporting grid stability and reliability.
- Interruptible products, providing the needed load reductions, outperformed expectations.
- The Reserve Sharing Agreement with Louisville Gas & Electric/Kentucky Utilities, in which LGE/KU and TVA make energy available to each other when outside assistance is needed, worked as designed.
- TVA's Regional External Relations Model enabled strong local engagement and outreach with customers, public officials and communities to help resolve challenges.
- TVA's Transmission system performed well throughout the storm.
- TVA's principal carbon-free assets (nuclear and hydro), which were not negatively impacted by the extreme cold weather that affected other generation technologies.

## Financial impact to TVA

**TVA also performed an assessment using available data and assumptions to calculate an estimated financial impact of Winter Storm Elliott. Overall, the financial impact to TVA totaled approximately \$170M, which included increased fuel and purchased power costs, costs of repair and hardening of assets, and lost revenue as local power companies and direct serve customers reduced their power usage during the storm. We estimate that residential customers with average energy use would have seen an increase of about \$5.20 in February because of Winter Storm Elliott.**



# What We Are Doing

Based on TVA's review the team identified a number of near- and medium-term actions to address the drivers and improvement opportunities. While TVA teams have already started addressing some of the actions, others are being planned to ensure completion in the coming months.

## ENERGY SUPPLY

### Site Resiliency

**Recommendation 1:** Conduct assessments and inspections to develop prioritized, site-specific improvement plans to address gaps in design basis. [In Progress]

**Recommendation 2:** Execute maintenance or upgrades for existing assets, in-flight projects, and new construction using the revised design basis and maintenance standards. [In Progress]

**Recommendation 3:** Revise maintenance standards to sustain the implemented resiliency improvements. [In Progress]

**Recommendation 4:** Establish standardized triggers and responses (e.g., stepped-up checklists, enhanced governance, temporary event-based roles) to be implemented immediately prior to extreme weather events to improve cross-organization coordination and communication. [In Progress]

**Recommendation 5:** Assess existing fuel resiliency strategy to identify areas where improvements can be made to strengthen resiliency readiness model at TVA's sites and within its fuel strategies and capacities. [In Progress]

### Energy Market Purchases

**Recommendation 1:** Establish process(es) to analyze and communicate market liquidity risks in seasonal and 10-day horizons. [In Progress]

**Recommendation 2:** Redesign Power Supply Update Report (PSUD) to better communicate market reliance risks (capacity position, net system position, risk based on purchases). [Nearing Completion]

## REAL-TIME LOAD FORECASTING AND OPERATIONS

### Load Forecasting Tools

**Recommendation 1:** Evaluate the prioritization and timing of necessary software updates to Itron and Tesla with TVA's Technology & Information Business Unit. [In Progress]

**Recommendation 2:** Evaluate options for data analytics application to better understand real-time risks and uncertainty in load forecasting during extreme events. [In Progress]

### Load Forecast Processes

**Recommendation 1:** Develop formal process(es) to improve coordination of load forecasting between real-time operations and Enterprise Forecasting for extreme events. [In Progress]

### Capacity

**Recommendation 1:** Establish documented attributes and guidelines for capacity related to external sources. [Nearing Completion]

**Recommendation 2:** Define risks associated with non-capacity products. [In Progress]

## EMERGENCY PROTOCOLS

**Recommendation 1:** Develop and update procedures and documentation used to implement and execute Emergency Operations Centers and the Agency Coordination Center, including triggers and checklists. [In Progress]

**Recommendation 2:** Improve crisis management technology, content, and emergency activation drills. [In Progress]

**Recommendation 3:** Improve existing and develop new agency-wide emergency and crisis management training. [In Progress]

**Recommendation 4:** Update Emergency Load Curtailment Program (ELCP) to incorporate lessons learned and feedback from LPCs. [Nearing Completion]

## CUSTOMER AND STAKEHOLDER ENGAGEMENT

**Recommendation 1:** Develop coordinated response plan, process, and templates. [Nearing Completion]

**Recommendation 2:** Ensure training, education, and maintenance of processes and information for coordination and communication. [Nearing Completion]

**Recommendation 3:** Ensure centralized access to information, clearly defined roles, and execution of process. [In Progress]

## Strategic Considerations

TVA's After-Action Technical teams identified key strategic considerations to inform decisions over the long term, which cover potential changes to the approach or execution of TVA's strategy that could help support an improved response to future hazards. These were reviewed by TVA's Enterprise Leadership Team, the Customer Engagement Team and the Blue-Ribbon Commission. These Strategic Considerations include:

- Continue assessing risks in capacity planning.
  - Implications of extreme weather on capacity planning and operational preparation
  - Market purchase risks for long-term and short-term capacity needs to support load growth (energy security and resiliency)
  - Fuel resiliency and redundancy
  - Qualities and criteria for generation resources to be included as capacity in resource plans
  - Implications of continued economic development, electrification, and available energy efficiency opportunities on load forecasts
- Expand power demand response and distribution system control.
  - Volume of responsive load (demand response products)
  - Technology improvement for distribution system automation and control
- Engage with customers, key stakeholders, and communities to identify opportunities to invest in emergency preparedness, resilience, and communication technology improvements.

As TVA includes these considerations in decisions going forward, we will work closely with our customers, stakeholders and policy makers to explore and support options that help support the energy needs of the future.

# Looking Forward

At TVA, we are committed to delivering energy that is affordable, reliable, resilient, and clean. As people's reliance on electricity continues to grow, so does the critical role it plays in people's lives.

Our region is a great place to live and work. Economic development, combined with overall population growth, is driving energy demand. After nearly a decade of flat growth, our seven-state region is growing at six times the national average – resulting in a nearly 3% increase in power demand from 2019 to 2022.

TVA is aggressively working to meet this challenge by investing in new generation and infrastructure. The region's ability to continue to thrive – to attract new jobs and investments – requires clean, sustainable energy.

By then end of the decade, TVA anticipates adding 10,000 to 14,000 megawatts of new generation to meet that demand. Today, we are building 3,800 megawatts of new generation, including solar energy, energy storage, combustion turbines, and combined-cycle natural gas. We are also investing in infrastructure, enhancing our transmission system and building a state-of-the-art System Operations Center in Meigs County, Tennessee.

Communities and businesses alike benefit from affordable, reliable, resilient, and clean energy. We are committed to delivering that energy today and tomorrow.

Here's our plan of how to help meet the region's growing capacity, with the goal of always providing the energy security people can rely on:

- Fiscal Year 2014 and 2022, TVA invested **\$18 billion** in capacity expansion and base capital, including about **\$1 billion** a year, to maintain existing assets.
- Between 2023 and 2027, TVA will invest **\$12 billion** for capacity expansion and base capital.
- We are building about **3,800 MW** of new generation, including combustion turbines, solar projects, combined-cycle natural gas, and energy storage.
  - **750 MWs:** Simple cycle CTs at Colbert (3 – 250 MWs) – Late 2023
  - **750 MWs:** Simple cycle CTs at Paradise (3 – 250 MWs) – Late 2023
  - **1,500 MWs:** Combined cycle at Cumberland – Late 2026
  - **500 MWs:** Peaking aero-derivative CTs at Johnsonville – Late 2024
  - **200 MWs:** Solar at Lawrence County – Late 2027
  - **20 MWs:** Battery at Vonore – Late 2023
  - **100 MWs:** Shawnee Solar\* – Late 2028

*\*Pending environmental reviews*



- We are investing in our current assets to ensure they are running as effectively and efficiently as possible – that we're getting every megawatt we can.
- We are evaluating responses to the 5,000 MW carbon-free RFP and expect to make selections this summer.
- We have 1,000 MW of new supply contracts in place since Winter Storm Elliott.
- We currently have 1,600 MW of demand response and are looking to add more.

As we work to address these challenges, the strength of our partnerships cannot be overstated. Key partners include our 153 local power companies, direct serve customers, elected officials, industry partners, communities, and more. Working together, we will ensure our region continues to have energy security, which includes sustainable energy solutions, and economic opportunities for generations to come.

# Appendix

## After Action Findings

Finding	Type
<b>Energy Supply</b>	
Rain followed by extreme cold weather and wind created an environment that was beyond design basis for TVA generating sites, causing some units to trip offline creating a generation deficiency	Driver
Due to the regional nature of the weather event, energy market purchases were curtailed, contributing to the generation deficiency	Driver
Gas pipeline communication, pressure alignment, and troubleshooting could be improved to enhance TVA's resiliency to future extreme weather events	Improvement Opportunity
TVA's principal carbon-free assets (nuclear and hydro units) were not negatively impacted by the Event despite the extreme cold weather that impacted other generation technologies	Strength
Sites remained focused on employee safety during the Event and were able to successfully perform all duties without incident during the Event	Strength
<b>Real-Time Load Forecasting and Operations</b>	
Operational/real-time industry load forecasting tools did not accurately predict the load and potential risks experienced during Winter Storm Elliott	Improvement Opportunity
Assess risks in capacity planning	Strategic Consideration
TVA does not have a uniform definition of capacity	Strategic Consideration
The Reserve Sharing Agreement with Louisville Gas & Electric/Kentucky Utilities functioned as designed	Strength
<b>Emergency Protocols</b>	
TVA's Transmission and Operations Center executed the ELCP as designed	Strength
Across the Agency, there were opportunities for better coordination and implementation of emergency procedures and protocols	Improvement Opportunity
Local Power Companies provided the needed load reductions when called upon to support grid reliability	Strength
Interruptible products outperformed expectations	Strength
<b>Customer and Stakeholder Engagement</b>	
Internal and external information flow and response was not timely or fully effective, resulting in inconsistent knowledge and external messaging, lack of situational awareness and expectations, and slow internal coordination, approvals, and stakeholder responses	Improvement Opportunity
TVA's Regional External Relations Model enabled local engagement and outreach with customers, public officials, and communities to help resolve challenges	Strength
<b>Transmission</b>	
Transmission system performed well during Winter Storm Elliott	Strength



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