CASE STUDY

Nashville Electric Service (NES)

PROJECT

Control Center of the Future

TVA TENNESSEE VALLEY AUTHORITY

PROJECT COST **$3.8M**

ABOUT NES

ESTABLISHED
1939

SERVICE AREA
700
sq mi

CUSTOMERS

TOTAL
460,000

ADDING PER YEAR
12K-14K

Background

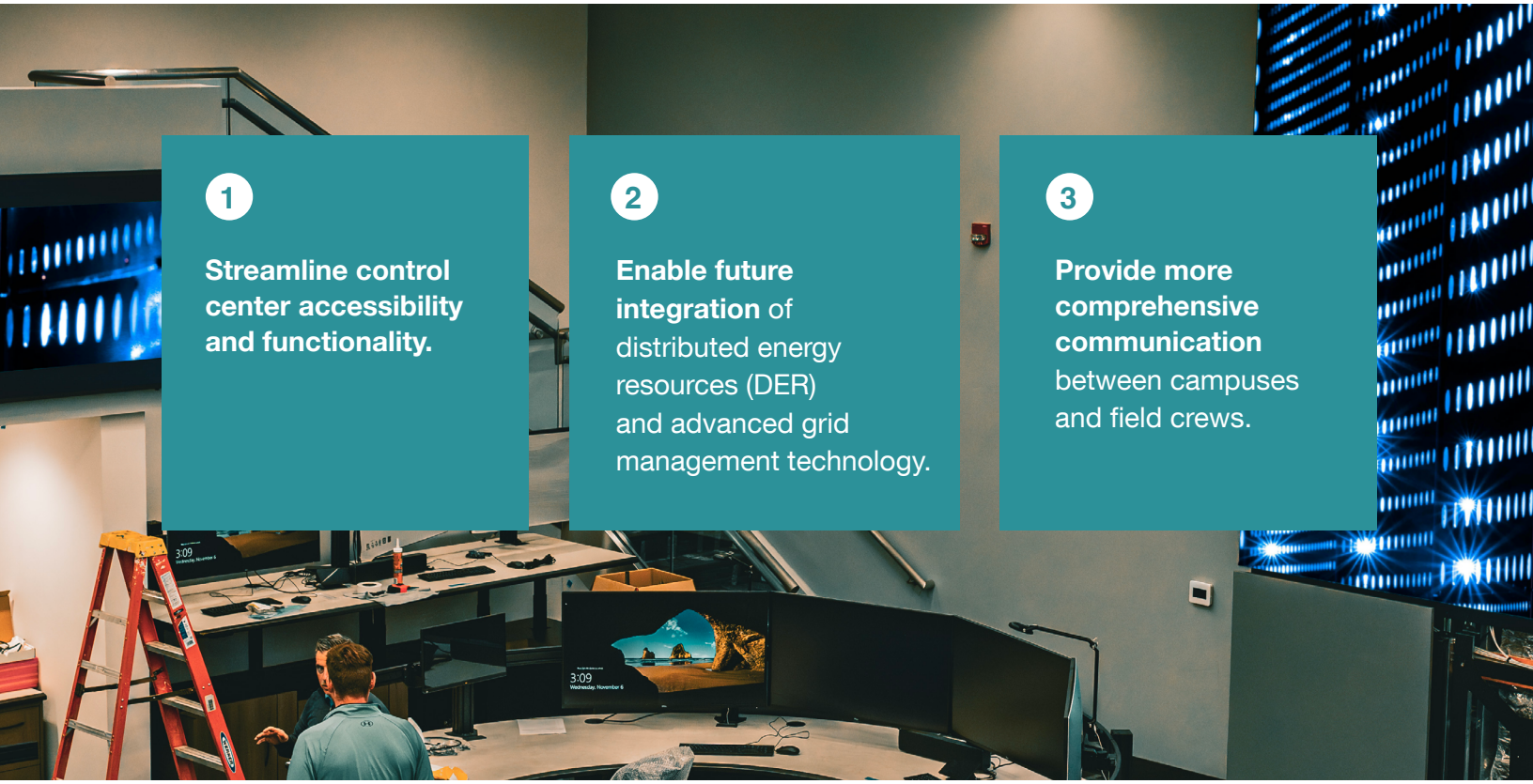
Nashville Electric Service (NES) is one of the largest public utilities in the nation, serving over 460,000 customers across 700 square miles in Middle Tennessee. Established in 1939, NES is growing at a rate of 12,000 – 14,000 customers per year, expanding in both service and technological advancements. NES continuously adapts to meet the energy needs of its customers and supports regional economic growth and grid modernization efforts.

One of the ways NES continues to grow is through the modernization of its control center. The first iteration of the control center began in 1990, with a push of modernization efforts that carried NES through 2001. In 2002, during the second-generation control center renovation, NES implemented key process changes, such as transitioning to a paperless system and replacing metal static boards with digital systems. This shift, although challenging, eliminated paper maps and manual switchboards, providing a foundation of digitization that would support future modernization. It marked the beginning of digital operations, and NES has continued to implement updates over time.

In preparation for a more dynamic and distributed grid, NES has completed renovations for a third-generation control center.

The continuous evolution of the control center's infrastructure and operations reflects NES's exemplary commitment to modernization and preparation for future grid priorities.

Project Goals



1. **Streamline control center accessibility and functionality.**

2. **Enable future integration** of distributed energy resources (DER) and advanced grid management technology.

3. **Provide more comprehensive communication** between campuses and field crews.

Supporting Grid Modernization

By investing in a modern control center, local power companies (LPCs) can benefit from advanced monitoring and management tools, allowing operators to better oversee the grid's performance in real time. This will enhance their ability to integrate renewable energy sources, manage DER and improve overall grid reliability and resilience. Upgraded control centers also bolster cybersecurity protections, ensuring that LPCs can readily respond to and mitigate evolving cyber threats. By modernizing these facilities, LPCs can optimize operational efficiency and streamline outage responses.

Modernizing control center facilities allows LPCs to enhance operational efficiency, improve outage responses, and align with the TVA's Regional Grid Transformation (RGT) initiative.

LEARN MORE ABOUT RGT

“We really debated about what we needed for our new control center. We were thinking about the types of technologies we needed to integrate, like a distributed energy resource management system and the possible need for a future dedicated distribution system operator.”

JACK BAXTER | VICE PRESIDENT OF POWER SYSTEM OPERATIONS, NES

Project Approach

In early 2021, the RGT Working Team – comprised of LPCs and regional stakeholders participating in RGT activities – evaluated potential pilot projects that would demonstrate meaningful ways for LPCs to support and progress grid modernization. Among the top priorities selected was a modernized “Control Center of the Future” project, as it would enable LPCs to prepare their operations hub for future grid-supporting technology.

NES, TVA, Electric Power Research Institute (EPRI) and consulting firm Guidehouse held collaborative discovery workshops to delve into NES’s objectives and future grid requirements of the control center. EPRI contributed valuable insights from previous control center projects, including comparisons between traditional control centers and those designed with consideration for advancement of control center technology, evolving operator roles and responsibilities and operator-centered design. This information provided a comprehensive view of the various types of control center setups and their potential applications, ensuring NES could consider all possible solutions.

Timeline

SUMMER 2021
RGT Working Group discussions held, involving activities and priorities to enable grid modernization

FALL 2021
Visioning and discovery workshops with NES, TVA, EPRI and Guidehouse to identify priorities

2022
Consultations held with specialty control center architect and renovation project teams

SUMMER 2023
Completion of a new backup control center to ensure a seamless operational transition

MARCH 2024
Construction began on the main control center

NOVEMBER 2024
Control center renovation completed and operational

Once the general scoping was in place, the NES team brought on a custom control room designer to ensure comprehensive planning and seamless execution. Enlisting a specialized designer provided expertise in integrating advanced audiovisual (AV) technologies and functional design, which were critical to the project's success.

A major consideration during the planning process was compliance with the North American Electric Reliability Corporation (NERC) standards, particularly those related to critical infrastructure protection (CIP).

NES had to carefully balance their operations network, which included supervisory control and data acquisition (SCADA) systems, with their corporate network. NES needed to ensure that sensitive control systems were not mixed with corporate data.

This required thoughtful planning to keep video walls and other critical infrastructure aligned with NERC compliance while maintaining system integrity throughout the project lifecycle.

NES weighed the investment of a new, more expansive and higher-resolution video wall, as the old one had poor resolution that rendered spreadsheets and detailed information nearly unreadable. Industry experts advised NES to upgrade their video wall, as it plays a crucial role in monitoring and controlling grid operations through improved visualization and situational awareness. After consulting with their control center designer who had experienced similar decisions, NES decided to include a state-of-the-art video wall in the project scope, ensuring that future operational needs would be met.

To gain further insights, the project team visited several control centers within the TVA service area and beyond. A notable visit

"This is software and technology that's already available, but we're rethinking how it's visualized and whose hands are putting that information into action."

JACK BAXTER | VICE PRESIDENT OF POWER SYSTEM OPERATIONS, NES

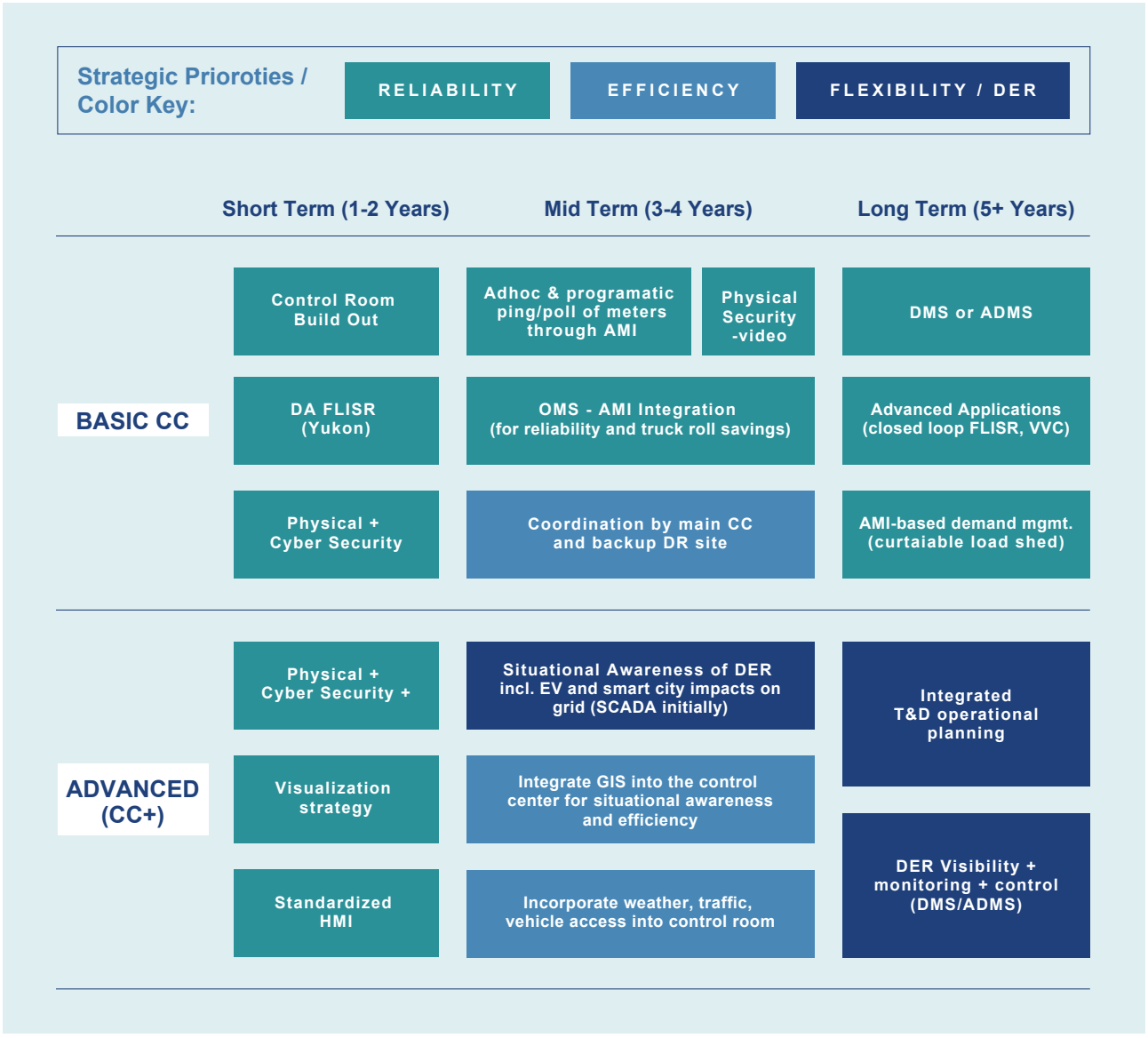
to Portland General Electric in Oregon, which had recently completed a modern control center, provided valuable lessons that directly influenced NES's design choices. Portland General Electric shared their experiences with new technologies, security checkpoints and layout designs. This intelligence helped NES streamline their decision-making process and avoid potential pitfalls.

Once the design was approved in early 2024, NES grid operations were relocated to their backup control center held in a satellite disaster recovery location. This relocation was only executed after all necessary equipment and resources were confirmed to ensure the construction of the new control center would begin in February 2024 as planned, preventing the disruption of daily grid management for longer than was necessary to complete the project.

Construction was completed in December 2024.

The result was a modernized control center designed to support future grid operations, improve situational awareness and enhance the overall efficiency of NES's control and management of current and future grid systems.

Roadmap for NES Control Center Modernization



TOTAL INVESTMENT

$3.8M

Results

Control Center Enhancements High-Resolution Video Wall

The new video wall, although smaller than the previous one, features a higher-resolution video wall that is connected to the corporate network, rather than the operations network, providing greater functionality and flexibility for information sharing. This setup allows the control center to leverage a SCADA viewer application that archives screens in a database accessible by entities outside of the Control Room environment, such as engineering teams. NES decided to implement a viewer system that pushes all SCADA screens and data to external displays, providing near real-time information with a slight delay of up to five minutes. Typically, the data is less than a minute old, which is sufficient for most users who are not making immediate operational decisions. This method allowed NES to have greater flexibility with the new video wall while maintaining its NERC CIP compliance obligations. Additionally, if operators choose, the video wall in the main control center can be synced to the meeting room monitor during emergencies, providing critical, up-to-date situational awareness for executives and other decision-makers.

Stakeholders Involved

Nashville Electric Service

Electric Power Research Institute

Guidehouse Consulting

Mauell Corporation

Moody Nolan

Tennessee Valley Authority, Regional Grid Transformation

Blue Sky, Grey Sky, Black Sky

The new video wall includes presets that allow system operators to view crucial outage information without manually accessing multiple web pages. This enhancement improves efficiency by displaying relevant data in a centralized location, especially during high-demand situations like storms.

PRESET MODES

Blue Sky Mode

On blue sky days, when operations are normal, much of the video wall may remain blank.

Black Sky Mode

Black sky mode is activated during severe events, providing comprehensive situational awareness integrating outage information from multiple sources.

Grey Sky Mode

As conditions escalate, grey sky mode displays critical information – such as outage maps from neighboring utilities – to all system operators, not just those managing the storm and advanced weather data.

Tour Mode

Tour mode is designed for visitors, displaying non-sensitive information to comply with cybersecurity standards.

The preset configurations streamline control center operations, ensuring critical data is easily accessible during emergencies while maintaining compliance with security protocols.

Kevin Phelps, operations manager at NES, demonstrates operational cockpit console

Operational Expansion

The new control center design increases the number of consoles from four to seven, including six cockpits and a standing console. This upgrade supports NES's growing distribution system and prepares for future management of distributed energy resources (DER), particularly during major storm events. It is part of a broader strategy to prepare for active DER management once the Distributed Energy Resource Management System (DERMS) is integrated, ensuring readiness for grid modernization and DER integration.

4 → 7

Expands the number of consoles from four to seven.

Six Dispatcher Cockpits

To enhance functionality and ensure grid operations could be maintained in all conditions, six operational cockpits were strategically positioned and installed to support collaboration and communication among operators. Each cockpit is designed for a single operator and features respective climate control and multiple monitors laid out in a semi-circle, optimizing visibility and comfort for operators. The primary command cockpit features a monitor that can be casted and streamed to the video wall, better enabling information sharing and communication among all command center occupants and leadership.

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Dispatcher cockpits needed to support collaboration and communication among operators.

A typical shift will have four operators—two dispatchers and two trainees—stationed at the four cockpits closest to the high-resolution video wall. During shift change, the two remaining cockpits can be utilized by the relief dispatchers, allowing them to get online and up to speed faster, streamlining situation handoff and ensuring a seamless shift transition during crisis.

NOC/SOC Addition

The new control center layout incorporates a Network Operations Center / Security Operations Center (NOC/SOC). NES has an extensive communication network that connects all of its transmission and distribution assets to the control center. Monitoring the operations communication network is just as important as monitoring the transmission and distribution system. The NOC/SOC provides a space for enhanced monitoring of crucial cyber assets that improve the visualization of tools that monitor the health of the network and help protect it from cyber threats.

Lessons Learned

Evaluate Control Center Design Through Site Visits

To make informed decisions about the design of a new control center, a visit was conducted to Portland General Electric, a utility known for its advanced control center setup. During the visit, several key insights emerged regarding access control and equipment handling. It was observed that the implementation of mantraps[1], although highly secure, presented significant challenges in terms of equipment access and operational efficiency. The process of moving equipment in and out of the control center was cumbersome, involving complex security protocols and potential delays. This experience highlighted the

[1]A mantrap is an access control system that consists of a small space or room situated between two secure doors, only one of which can be opened at a time.

need for a more practical access control solution. By choosing a hybrid approach that combined elements of mantraps with simpler methods, NES saved approximately $300,000 and avoided many operational inefficiencies. This visit underscored the value of learning from other facilities' experiences to make better design and operational decisions.

Engage Experts Specializing in Control Center Design

When considering a new control center, it became clear that collaborating with experts specializing in control center design was crucial. While an initial architect had been involved in previous renovations, the NES team decided to engage with a firm that had extensive experience in designing various types of control centers. These specialists brought valuable insights into human-machine interface (HMI) design and data visualization that were beyond the scope of general architecture firms. Their expertise helped to avoid common design pitfalls and ensured that the control center would meet both current and future operational needs.

Ensure Backup Control Center Readiness Before Construction

Before initiating construction, the NES team evaluated the backup control center which revealed that the existing facility, initially a small room with minimal SCADA capabilities, was inadequate for long-term needs. Recognizing the need for a more robust solution, NES upgraded the backup facility to ensure it could support operations during major disruptions. A new disaster recovery center was constructed, incorporating modern security measures, fiber connectivity and expanded office space. Although the project faced delays due to supply chain issues, the completion of the backup site allowed for a smooth transition while the main control center underwent renovation. This experience emphasized the importance of having a well-prepared backup control center and planning for potential disruptions in supply chains.

"There are certain tasks that have to take place to operate a utility, whether you're a 10,000 customer muni, 30,000 customer co-op or 4 million customer IOU. You'd better have a backup control center... somewhere else should something happen to your primary operating center."

JACK BAXTER | VICE PRESIDENT OF POWER SYSTEM OPERATIONS, NES

Plan for Flexible and Future-Proof Technology Integration

The decision to invest in a new video wall addressed previous issues with poor resolution that affected the display of critical data. This decision was influenced by consultations with experts and workshops that emphasized the future need for high-quality visualization technology. The new system not only improved data display but also supported flexible integration with remote operations centers, enhancing NES's ability to conduct real-time collaboration and visualization using advanced tools and technologies.

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Despite the high initial costs, the investment was deemed worthwhile as it provided a more adaptable and future-proof solution.

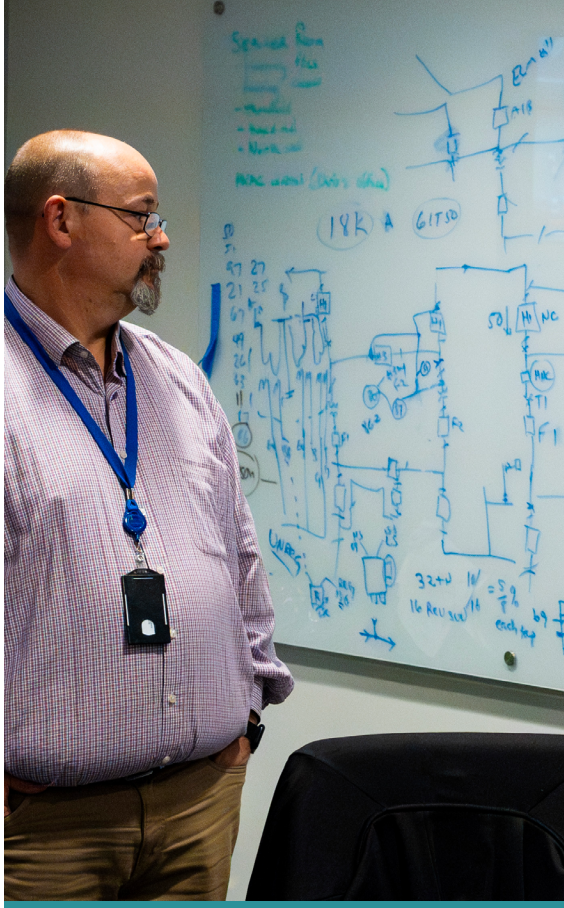
Looking Ahead

As the NES team uses the updated control center, future steps include evaluating how the setup performs and determining additional requirements for remote operations centers.

Future Technology and Process Enablement

The development of the new control center involved careful consideration of necessary technologies and future integrations. Planning for DER integration was essential due to the expected longevity of the control center, and provisions were made for future incorporation of a DERMS, with the current setup designed to accommodate anticipated needs. The design also focused on enhancing existing spaces, systems and processes to ensure better functionality and adaptability over time, minimizing the need for any future upgrades or renovations. For example, neighboring rooms that once were visually disconnected from the main control room have been redesigned with window walls and connected devices, expanding visibility into ongoing operations and the overall usability of those spaces. As DER and other technologies are integrated into grid operations, these flexible spaces can be used for training, oversight, troubleshooting or other emerging needs.

This forward-thinking approach aims to address evolving needs and improve the management of emerging technologies as the regional grid continues to transform based on future demand.



“A lot of what we were doing and the choices we were making was based on the technology we had available. Now, we have the flexibility to play with the options and see what works best for us. That’s the really exciting part.”

KEVIN PHELPS |
OPERATIONS MANAGER, NES

Streamlining Communications Across the Organization

Going forward, the plan includes creating “smart conference rooms” at NES’s three remote operating centers, equipped with smart boards that allow real-time interaction with the main control center in emergency events. While overhead line crews are stationed at these remote centers, emergency management has historically been conducted from a central location. The modern control center will enable remote teams to collaborate on maps and visual data seamlessly, drawing and discussing strategies across locations in real time, ensuring a more integrated and efficient response during extended recovery efforts.

PLAN INCLUDES

Creating smart conference rooms for real-time interaction with the main control center during emergencies.

“On the immediate horizon is to look at our technological roadmap for system operations and decide what the future looks like, and we think we’ve future-proofed our control center to handle whatever we decide to do.”

JACK BAXTER | VICE PRESIDENT OF POWER SYSTEM OPERATIONS, NES

LEARN MORE

The Regional Grid Transformation (RGT) initiative is a collaboration between local power companies and TVA to transform the power grid into a more resilient, flexible and integrated system to meet customer expectations and changing world conditions.

Visit tva.com for details.