TVA's Energy System of the Future

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1920s: Hard Times in the Tennessee Valley

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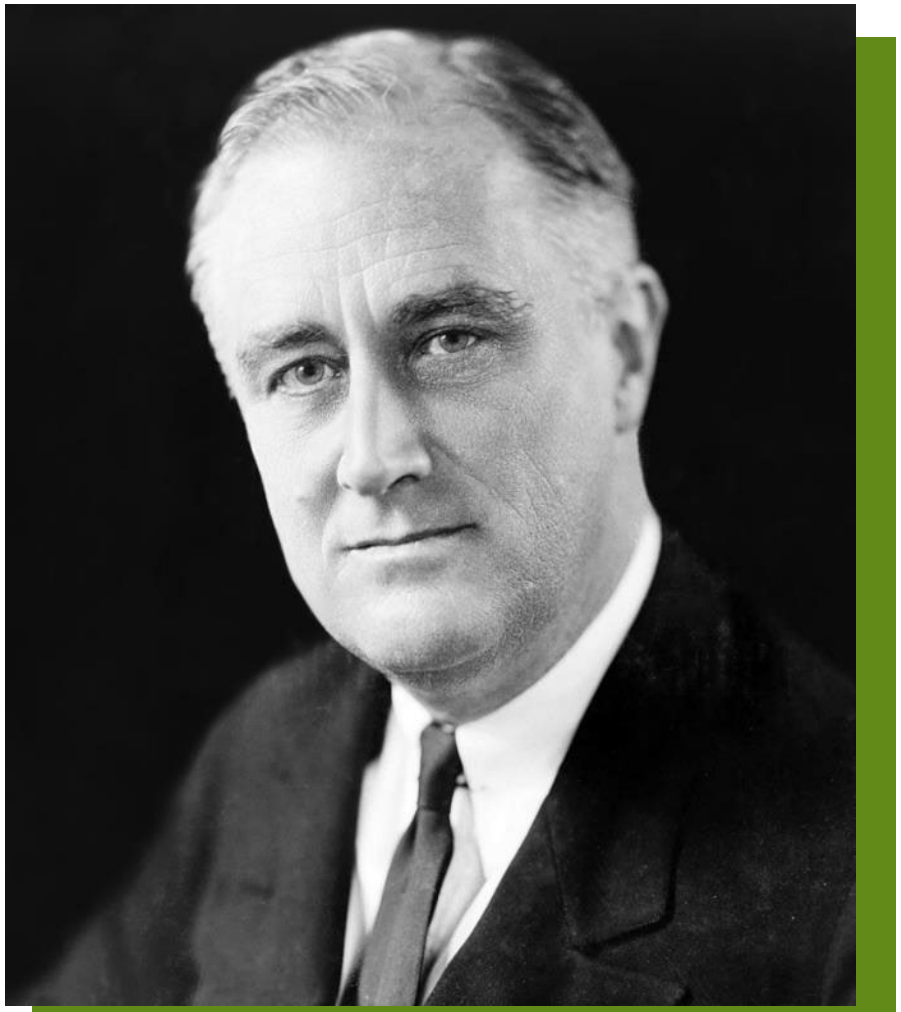
Improve Standards of Living



"Power is really a secondary matter…TVA is primarily intended to ***change*** and to ***improve*** the standards of living of the people…"

-President Franklin D. Roosevelt

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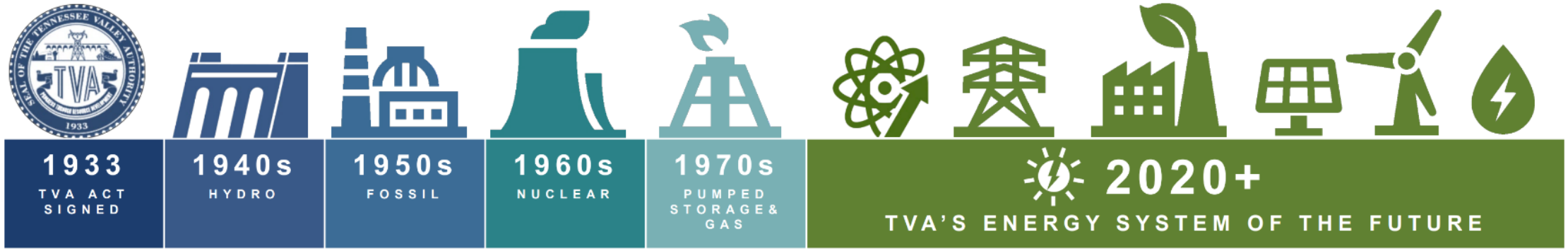
TVA Mission

BUILT FOR THE PEOPLE OF THE VALLEY

ENERGY — Electricity at the lowest feasible rate and highest feasible reliability

ENVIRONMENT — Stewardship of the natural resources for best use by the public

ECONOMIC DEVELOPMENT — To attract and retain good jobs and capital investment in the Valley



Since its inception, TVA has innovated to meet the needs of the Valley.

Today and in the future, the Valley needs **affordable, reliable, resilient, and carbon-free energy** to **lead the nation in energy innovation and economic development**.

INNOVATING FOR THE PEOPLE OF THE VALLEY

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A Rich History of Innovation and Catalyst for Change

Agriculture
Pre-1940

- Agriculture (Fertilizer)
- Rural Electrification
- River Management
- Hydro Production

Manufacturing
1940s – 1990s

- WWII Support
- Manufacturing
- Coal Generation
- Nuclear

Information
2000s - Current

- Advanced Nuclear
- Connected Communities
- Decarbonization
- Electric Vehicles
- Energy Efficiency
- Future Grid Performance
- Gas Generation
- Regional Grid Transformation
- Renewables/Wind
- Storage Integration

Energy Economy
Future

- Advanced Nuclear
- Virtual Power Plants
- Widespread Electrification
- Hydrogen Economy
- Low/No Carbon Generation
- Digitization
- Cybersecurity
- Augmented/Virtual Reality
- Artificial Intelligence
- Machine Learning

TVA System Today

Partnering with 153 local power companies that supply electricity to approximately 10 million people across seven Southeastern states with 57 directly served customers, including 50 industrial customers and 7 military and federal installations.

Generating Assets

- 3 Nuclear Sites (7 Units)
- 5 Coal-Fired Sites (25 Units)
- 29 Hydroelectric Sites (109 Units)
- 1 Pumped-Storage Site (4 Units)
- 9 Combustion Turbine Gas Sites (86 Units)
- 8 Combined Cycle Gas Sites (14 Units)
- 1 Co-Generation Unit
- 14 Solar Energy Sites

Largest Public Power Provider
In the United States

3rd Largest Electricity Generator in the Nation
Based on Total Electric Generation in 2020

One of the Nation's Largest Transmission Systems
In high voltage lines among United States Utilities
16,400 miles of high voltage lines and
69 interconnections with neighboring electric systems

3rd Largest Nuclear Fleet
In the United States, providing over 40% of TVA's energy

99.999% Reliability Since 2000
Top-decile industry performance

Over
40,000 Miles of Rivers, Streams and Tributaries
Including the 652-mile Tennessee River

Approximately 350,000 Jobs & Almost $46 Billion
Capital investment in the Tennessee Valley generated by TVA economic development activity over the past five years

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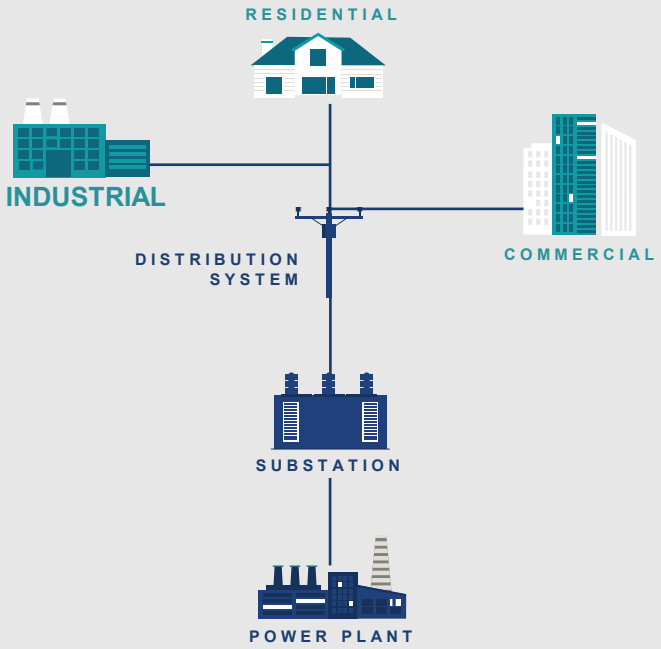
Energy System of the Future

Increasing energy system complexity requires planning, integration, and innovation

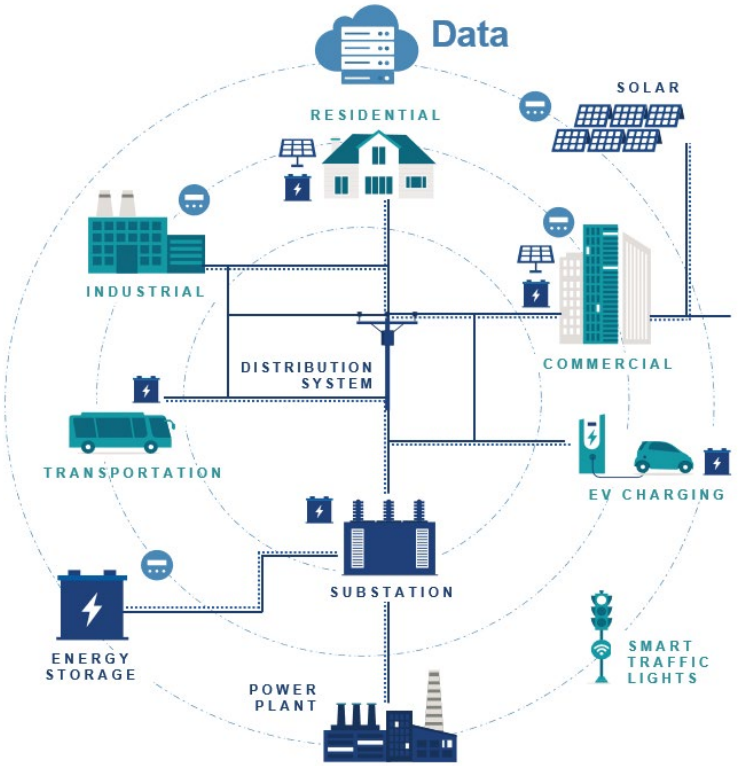
Legacy Energy Grid



Emerging Drivers

- Electric Vehicles
- Valley Electrification
- Economic Development
- DERs / Storage
- Demand Response
- Variable Renewable Energy

Energy System of the Future



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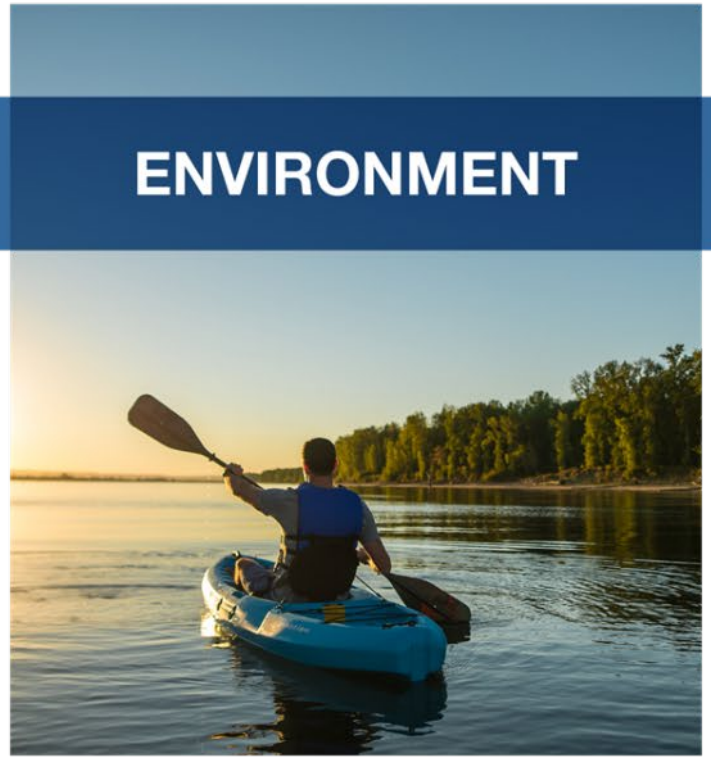
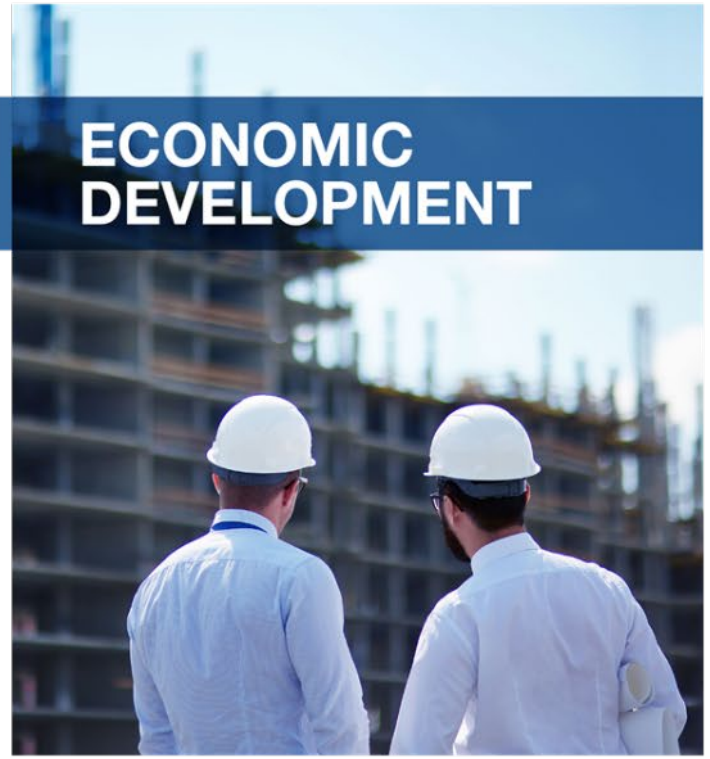
Delivering Our Mission to You

Provide ***affordable, reliable*** power.



Steward the Valley's ***natural resources***.



Partner for ***economic growth***.

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Energy System of the Future

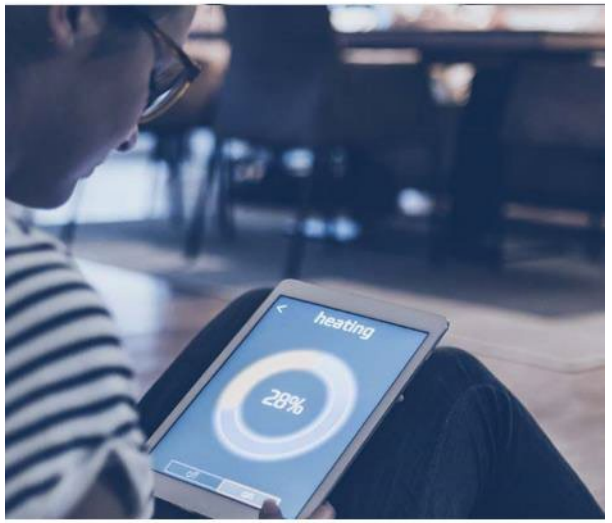
Reinforce Reliability

Provide efficient, reliable, resilient power

Protect the Environment

Integrate clean, renewable energy sources

Keep Power Costs Low



You are in control of your energy dollar

Grid of Tomorrow | System Operations Center | Advanced Nuclear Solutions | Clean Energy

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Innovation and Research

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Advanced Nuclear Solutions

Provide reliable, affordable, flexible, and clean generation options

Small Modular Reactors

- Zero Carbon Emissions
- Benefits of nuclear with lower capital cost
- Operational Flexibility & Grid Stability
- Price Stability
- Little or no fuel cycle risk
- Small footprint, reduced emergency planning zone

Decarbonization Options

Advance a suite of technologies to cost-effectively reduce TVA's carbon footprint to net-zero

Carbon capture, sequestration & utilization

Alternative fuels

Renewables + storage

Electrification

Advanced nuclear

Future Grid Performance

Maintain a stable and reliable grid while fostering the evolution of the Energy System of the Future

- Improve processes to facilitate a fast-paced and evolving resource mix with new technologies
- Optimize approaches and tools to ensure system stability and performance in the future grid
- Evaluation and adoption of new grid technologies

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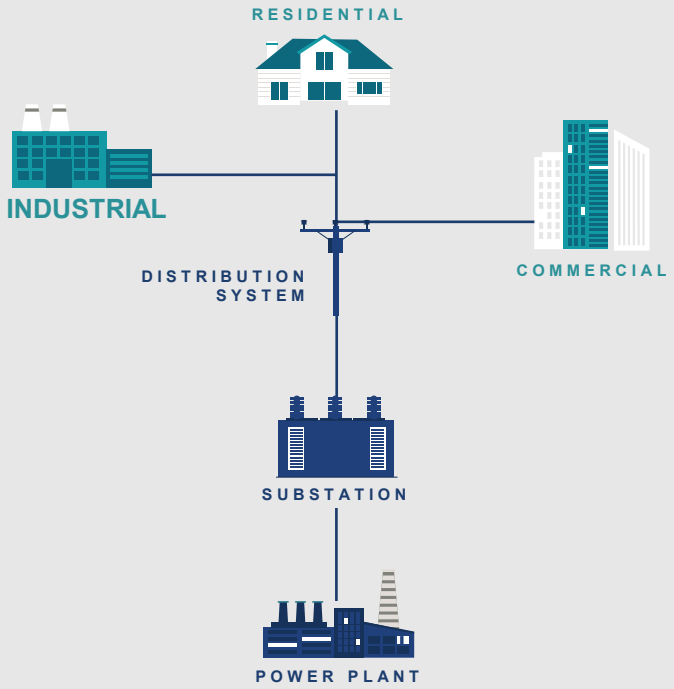
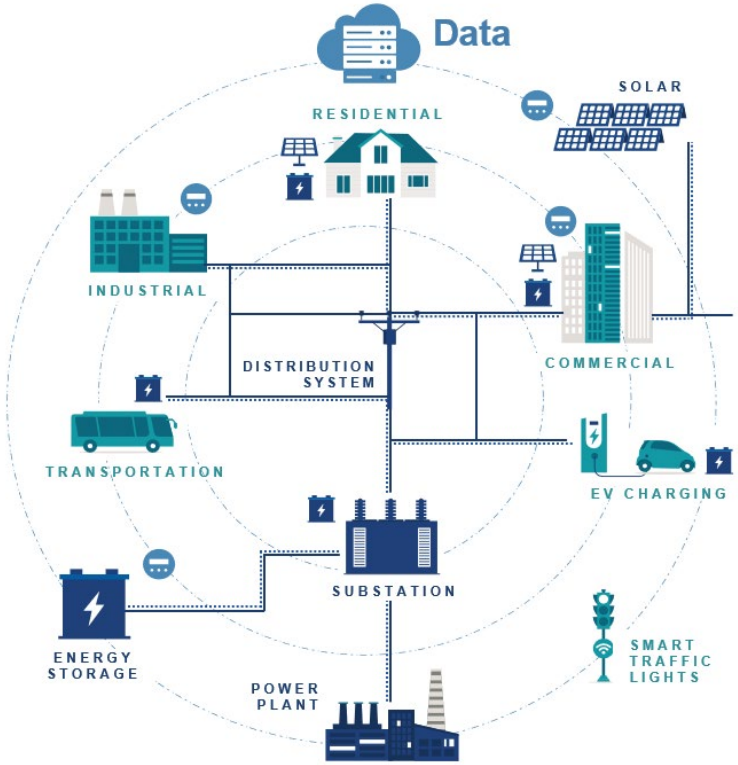
Regional Grid Transformation



Traditional

Current power grid



Future

Transformative grid

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Connected Communities

A Connected Community uses data and technology to offer new and improved services to its people and businesses.

Faster and more accessible internet for all

More information at your fingertips

Access to education and training programs

Grid-interactive buildings and resources

Government modernization through digitization

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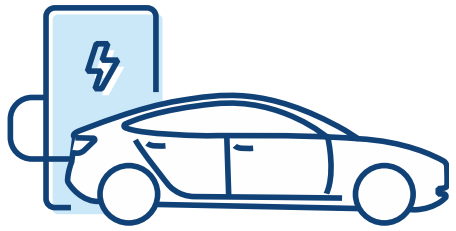
Electric Vehicle Evolution



Charging Infrastructure Availability

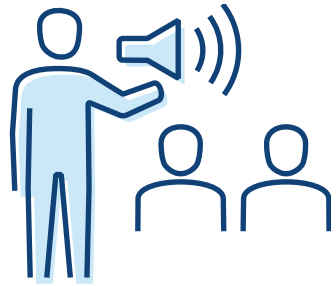
- Remove “range anxiety”
- Foundational EV charging network
- Partner with Local Power Companies (LPCs)

EV Availability and Offerings

- Partner with automakers and fleets
- Support making a wide range of EVs available

Innovative and Supportive Policies

- Remove utility policy or pricing barriers
- Craft policies and pricing that encourage investment and enable a market



Consumer Awareness

- Help consumers make sound choices
- Educate, inform, and promote while lifting TVA and LPC brands

Removing market barriers in key areas

Energy Storage

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A Case For Change

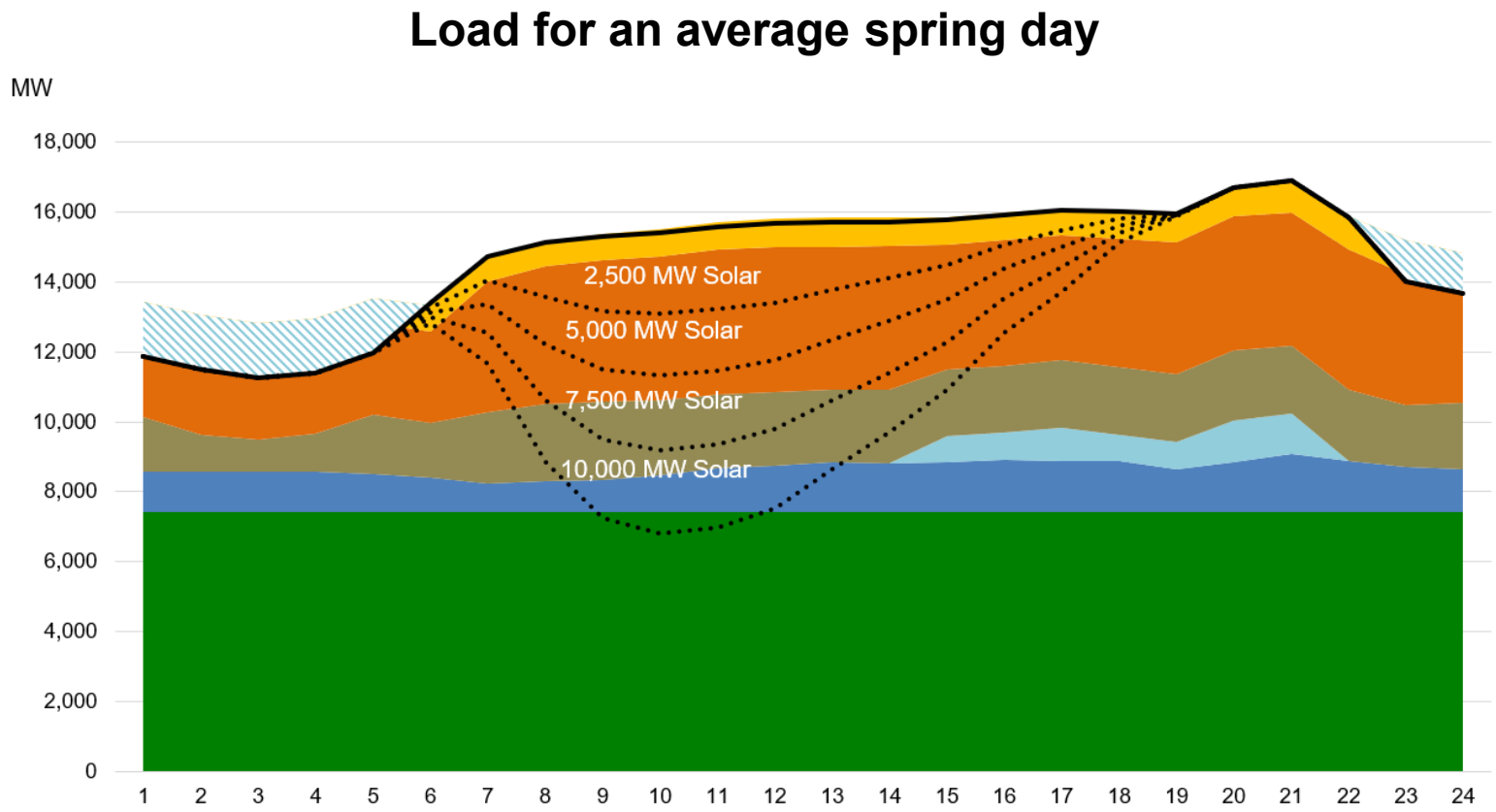
Solar: Flexibility and Capacity

Must Balance Generation and Load:

- Not enough is bad
- Too much is also bad

Major Issues:

- Variability
- Winter Capacity
- Large Ramps
- Curtailments



Models show TVA will need a mix of long duration and short duration storage

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Potential Battery Energy Storage TVA-Specific Use Cases

Voltage Support and Frequency Regulation

- Improve power quality near sensitive loads, such as data centers or industrial sites
- Maintain voltage at LPC delivery points

Transmission Support

- Could provide alternative to large fossil unit dispatch at lower load levels to provide local metro-area grid support
- Alternative method of transmission support for remote system locations (Geographically Isolated Areas)

Peaker Replacement
(Electrically Isolated Areas)

- Alternative to running CTs during transmission line outages for local grid support
- Alternative to running John Sevier on fuel oil during extreme cold events

Black Start

- Provide grid resiliency and local black start capability

Reserve Capacity

- Additional spin/non-spin reserve resource

Peak Load Shaving

- Reduce demand on capacity-constrained assets

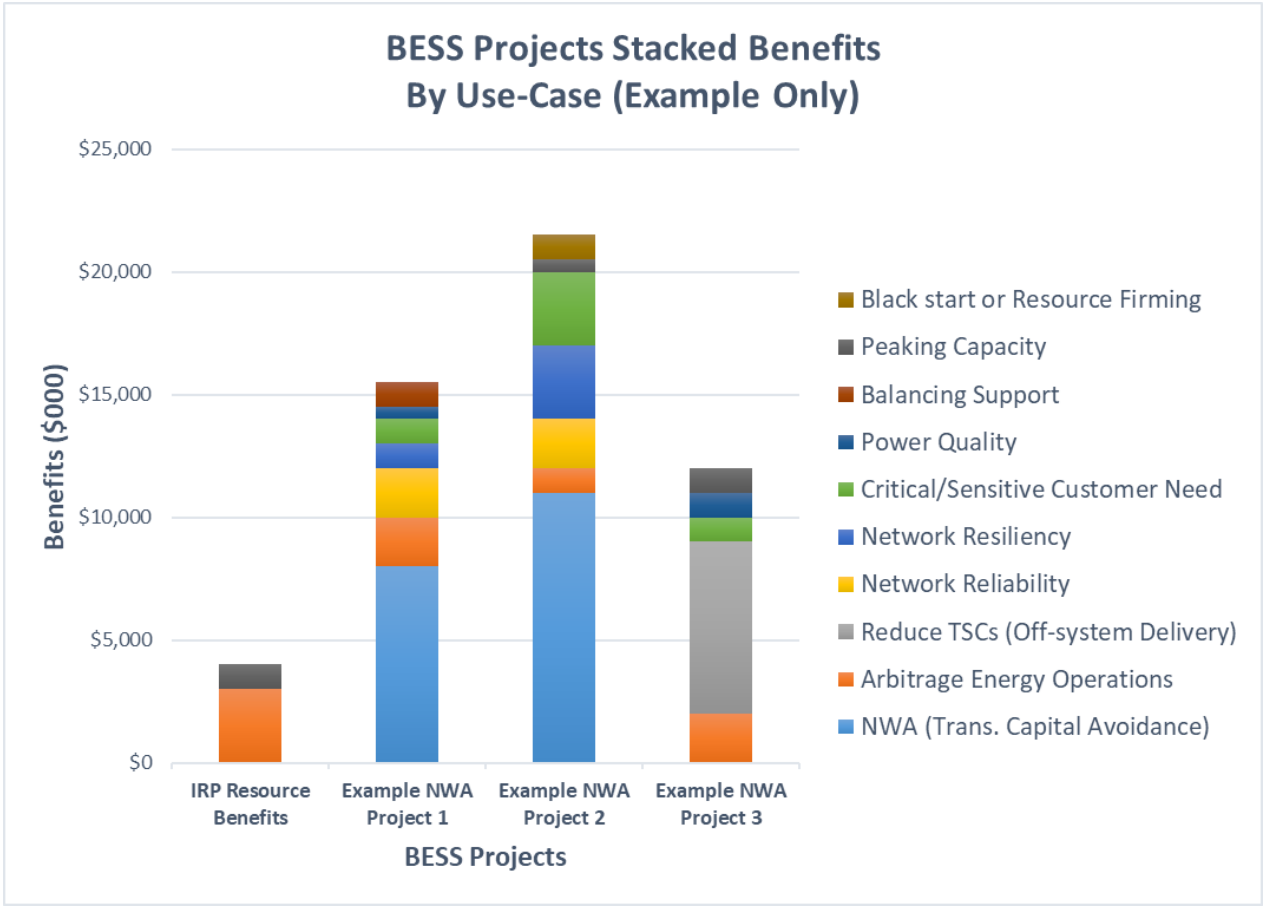
Battery Energy Storage System: Stacked Benefits

Locational (Distribution and Bulk System)

- **Resiliency/Microgrid:** Grid Forming Inverter
- **Voltage Support:** Dynamic real and reactive power support
- **Power Quality:** Power Quality for Industrial/Commercial loads
- **Economic Development:** Allow for quick load increases

Non-Locational

- **Peak Power:** Alternative to Gas Generation
- **Flexibility:** Renewable Generation variability
- **System Ramping:** Large solar and system ramps (duck curve)
- **Curtailment:** Allow Nuclear and Carbon Capture



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Long Term Storage Plan

Designed to give TVA process and operational experience to fully integrate grid scale storage into the power grid.

Transmission Battery Demonstration

- Develop TVA process and understanding
- Transmission Support: Voltage/Regulation
- Operational Strategies
- Lithium-ion chemistry – most widely used chemistry
- Safety Measures

Evaluating Emerging Technology

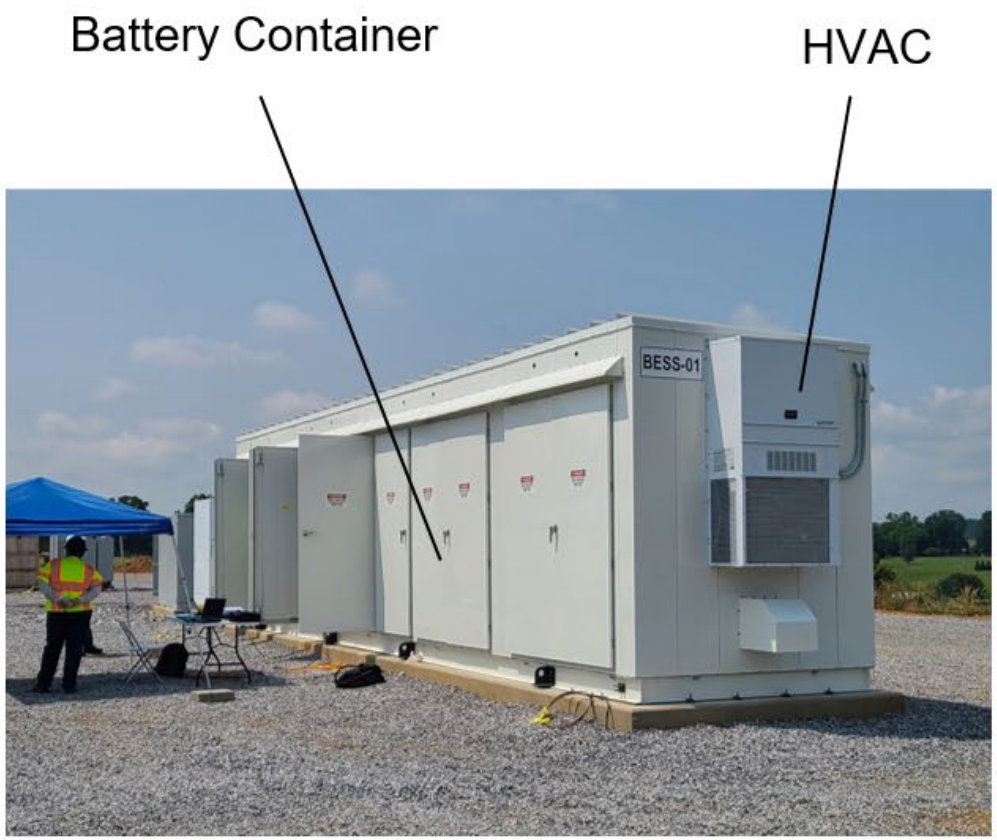
- Lithium-ion chemistries
- Flow Batteries – chemical batteries
- Hybrid storage systems
- Gravity Storage
- Pump storage

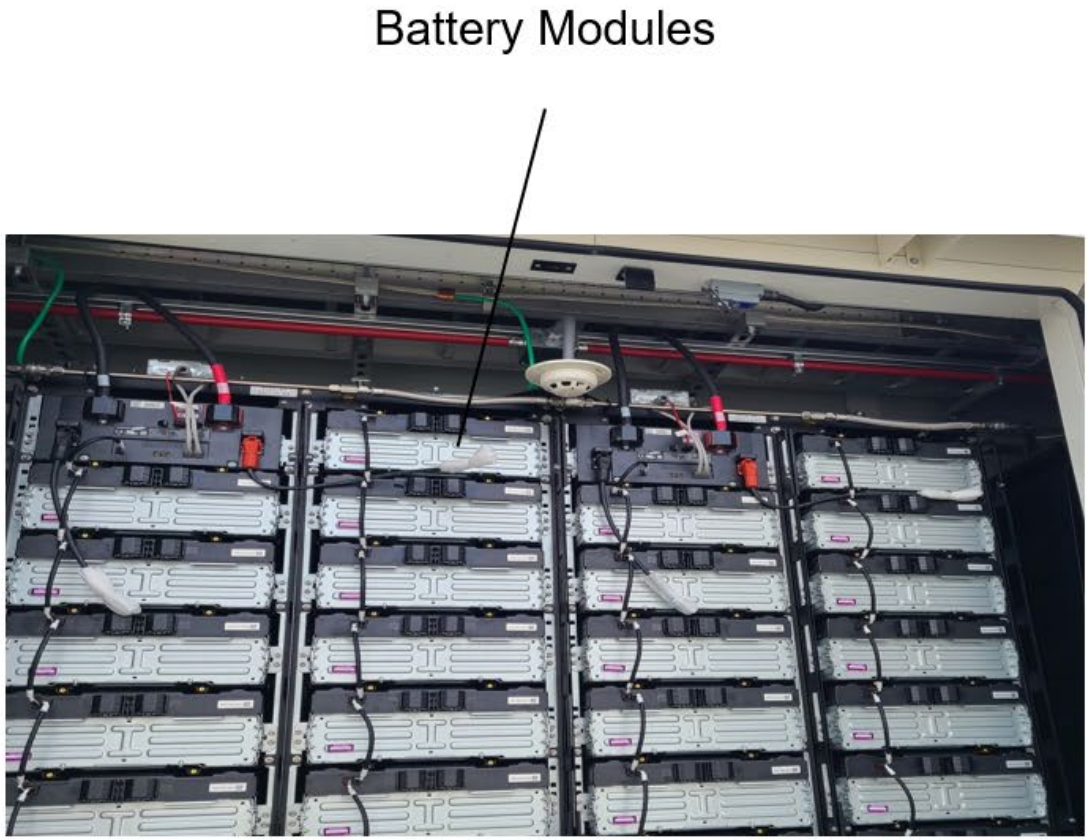
Distribution Battery Demonstration

- Communication and control
- Develop process
- Investigating shared asset benefits
- Integrate multiple small batteries into the TVA system

Battery Energy Storage System: Vonore

Vonore BESS- 20MW/40MWh (Dec 2023)





Pumped Storage

Rates:

- Lowest cost mature option for long-duration storage
- Regulatory and fuel cost risk reduction

Reliability:

- Requires less energy storage than traditional and renewable energy sources

Job Opportunities:

- Construction and ongoing facility operations and maintenance

Environmental Impact:

- Enables low-carbon energy generation, through additional solar, nuclear, and carbon capture technologies

Study Phase: land, environmental, and community impact assessments

Storage Integration Initiative

Implement a long-term strategy to integrate energy storage for system flexibility and maximizing renewables

Storage Technology	Typical Duration	Technology Maturity
Lithium-ion battery	2-4 hours	Being deployed
Flow battery	8+ hours	Demonstration
Gravity storage	8+ hours	Demonstration
Pumped storage hydro	8+ hours	Mature

Lithium-ion Battery

Flow Battery

Gravity Storage

Pumped Storage

Solar + Storage

Supports grid stability by balancing the supply and demand of electricity

- Enables time shifting of solar energy production, allowing excess energy to be stored during periods of low demand and used during peak hours, reducing strain on the grid.
- Growing residential storage will provide other benefits including supporting growth in electric vehicle (EV) adoption.
- Well-positioned to adapt to an increasingly electrified future by seamlessly integrating with EVs, heat pumps, and other connected home appliances.

Vehicle to Grid

- EVs are "batteries with wheels" and with the right equipment, can discharge electricity
- Potential use cases:
  - Emergency backup power
  - Demand response
  - Peak load reduction
- Example: discharge electric school buses during summer break to reduce summer peaks
- Technology is improving, but cost and complexity remain high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