Climate Action Adaptation and Resiliency Plan

As Submitted: August 16, 2021

TVA TENNESSEE VALLEY AUTHORITY

Table of Contents

Forward-Looking Statements

This *Climate Action Adaptation and Resiliency Plan* (Plan) contains forward-looking statements relating to future events and future performance. All statements, other than those that are purely historical, may be forward-looking statements. In certain cases, forward-looking statements can be identified by the use of words such as "may," "will," "should," "expect," "anticipate," "believe," "intend," "project," "plan," "predict," "assume," "forecast," "estimate," "objective," "possible," "probably," "likely," "potential," "speculate," or other similar expressions. TVA believes that the assumptions underlying the forward-looking statements are reasonable. Numerous factors could cause actual results to differ materially from those in the forward-looking statements. For a discussion of these factors, please see the annual, quarterly, and periodic reports that TVA files with the Securities and Exchange Commission. New factors emerge from time to time, and it is not possible for management to predict such factors or to assess the extent to which any factor or combination of factors may impact TVA's business or cause results to differ materially from those contained in any forward-looking statement. TVA undertakes no obligation to update any forward-looking statement to reflect developments that occur after the statement is made.

Publication Date: August 2021
Reporting: All references to years in this annual *Climate Action Adaptation and Resiliency Plan* refer to TVA's fiscal years ending September 30, unless specifically identified as calendar years and all financial data is reported in U.S. dollars.

Reporting Period: January 1, 2021 to December 31, 2021
Contact: climateactionplan@tva.gov

A Word from Our Chief Sustainability Officer

For the past 88 years, sustainability and integrated planning have been key elements of TVA's mission to improve quality of life for those who live in the Tennessee Valley. Both are essential as we face the challenges and opportunities of climate change. We will continue our work in creating resilient energy and flood management systems that will enable us to continue meeting our statutory mission.

This Plan outlines the ways that TVA is making life better for the people of the Valley by collaborating with the seven-state region to create a future adaptive and resilient to the impacts of climate change. To help in carrying out the climate adaptation and resiliency management activities described in this Plan, we will work together with our stakeholders to continuously improve our approach and the actions we take. We identify issues and opportunities that will help create a sustainable, resilient and reliable clean energy future. We are always striving to balance competing demands with one goal in mind--to do so in a way that best serves the Tennessee Valley.

We will continue our work through partnerships to understand the impacts of climate change and continue to develop tools, processes, and projects to enable our resiliency and adapt to change. In addition, we will continue to partner with communities to support increased adaptation and resiliency throughout the Tennessee Valley.

Rebecca Tolene
Vice President, Environment
Chief Sustainability Officer
Tennessee Valley Authority

TVA Statement for Climate Adaptation and Resilience

TVA's clean energy leadership is driven by its mission to make life better for the people of the Tennessee Valley, and a recognition that every investment in mitigating greenhouse gas emissions is also an investment in climate adaptation. We are innovating and partnering with the communities in the Tennessee Valley we serve to create a clean energy economy without compromising reliability and low rates, and to create a future adaptive and resilient to the impacts of climate change.

Our unique, long-standing mission of service is just as relevant today as it was when TVA began in 1933: To serve the people of the Tennessee Valley to make life better. As times have changed, TVA has changed with them by updating and refining our work to accomplish our mission of providing affordable energy, economic development, and environmental stewardship through integrated river system management, partnerships, and technological innovation. To deliver on our commitment to the 10 million people we serve, we build sustainability into everything we do--every decision we make, every project we undertake.

ENERGY: We power the Valley so it may grow and thrive

- Safely delivering affordable, reliable and increasingly clean and resilient power

ENVIRONMENT: We are stewards of the region's waterways and surrounding lands

- Responsible stewardship by caring for the region's natural resources

ECONOMIC DEVELOPMENT: We serve the Valley by attracting jobs and investment to our region

- Creating sustainable economic growth

Specifically, our *Climate Action Adaptation and Resiliency Plan* identifies:

- How climate change may impact TVA's ability to achieve its mission;
- Ways TVA can prioritize and measure its progress and its capability to adapt to current and future changes in climate;
- An analytical framework, references, tools and other guidance to help TVA planners understand how to consider climate change and build resilience in the short- and long-term--including guidance on how to use climate projections that involve multiple future scenarios and different time periods in planning and project designs;
- Affected TVA departments, budgets and actions identified under this statement, considering that TVA will be dedicating non-appropriated funds, as practicable, at its discretion;
- Coordination points with TVA's Leadership.

TVA maintains its *Climate Action Adaptation and Resiliency Plan* as a cohesive part of its major planning processes--including integrated resource management and planning, natural resource, and National Environmental Policy Act (NEPA) planning. As appropriate, TVA applies applicable Executive Orders (EO) as well as all guiding principles, and planning frameworks and guidance complementary to these EOs. TVA's purpose in enhancing preparedness for and resilience to the climate crisis includes areas that have co-benefits for mitigation and environmental justice. By seeking to anticipate the risks of extreme weather and climate change effects, TVA may be able to reduce climate-related risks to its facilities and the corresponding budgetary risks.

TVA's major planning processes, consistent with its *Climate Action Adaptation and Resiliency Plan*, identify opportunities as well as climate change risks with the potential to substantially impair, obstruct or prevent the success of Agency mission activities, both in the near-term and particularly in the long-term, using the best available science and information.

TVA will consider environmental justice impacts, consistent with its *Climate Action Adaptation and Resiliency Plan*, as well as any mitigation co-benefits in a manner appropriate for the process used.

As appropriate, TVA will coordinate with other agencies and interagency efforts, including the White House Interagency Environmental Justice Working Council, on climate change adaption issues that cut across agency jurisdictions.

TVA will update and revise its *Climate Action Adaptation and Resiliency Plan* annually and will incorporate the quadrennial publication of the *National Climate Assessment* within one year of its publication.

Adaptation Planning Coordination, Implementation and Delegations

TVA's Chief Sustainability Officer (CSO) is responsible for ensuring implementation of TVA's *Environmental Policy,* including all aspects of this adaptation and resiliency statement and the periodic reviews and updates necessary to confirm it remains relevant. This statement does not alter or affect any existing duty or authority of individual TVA business units.

TVA's Environment organization leads and has governance over TVA's Climate Action Adaptation and Resiliency planning and engages executives, subject matter experts and representatives from across TVA to work with TVA's Sustainability and Climate Program to provide leadership and focus for TVA's adaptation and resiliency efforts across the agency.

TVA's CSO and other leaders are tasked with aligning adaptation and resiliency planning goals and initiatives with their annual business planning process. Alignment with business planning ensures that resources are planned for and used most efficiently, and that opportunities to maximize sustainability benefits are identified and realized.

This statement is effective immediately and will remain in effect until amended, superseded, or revoked. Its implementation is subject to the prioritization of available funding.

JEFF LYASH
President and Chief Executive Officer
Tennessee Valley Authority
August 16, 2021

TVA Climate Action Adaptation and Resiliency Plan

1.0 About TVA: Mission, Values, and Planning Processes

Our statutory mission is defined in the TVA Act, and has remained constant since inception. TVA's mission focuses on three key areas:

1. **Energy:** safely delivering affordable, reliable, low-cost, increasingly clean power;
2. **Environment:** responsible stewardship by caring for the region's natural resources; and
3. **Economic Development:** creating sustainable economic growth.

Congress established TVA in 1933 and charged it with making life better in the Tennessee Valley. As the nation's largest public power provider, TVA safely delivers increasingly cleaner, reliable, affordable energy to 153 local power companies and 57 directly-served customers as of May 2021. TVA's service area, the area in which it sells power, is defined by the TVA Act. TVA supplies power in most of Tennessee, northern Alabama, northeastern Mississippi, and southwestern Kentucky and in portions of northern Georgia, western North Carolina, and southwestern Virginia, covering 80,000 square miles and serving nearly 10 million people. To learn more about our history, mission and values, click here.

Environmental goals are an integral part of how TVA does business, and these are tracked along with its other business objectives. TVA manages climate adaptation and resiliency within its environmental management system and its annual long-term asset and strategic planning processes. TVA's other long-term environmental planning processes include its *Integrated Resource Plan (IRP)* and its *Natural Resource Plan (NRP)*. Other applicable TVA planning processes include *Reservoir Land Management Plans* and the *TVA Shoreline Management Policy*. As a Federal agency, TVA must also comply with the *National Environmental Policy Act (NEPA)*, as well as applicable *Executive Orders*. These major long-term planning processes must include:

- An assessment of risks from extreme weather and climate change effects that are specific to the plan - as granular as practicable
- Plans to address those risks as appropriate

With generation assets, buildings, and over 16,000 miles of transmission lines and 500 substations throughout the Tennessee Valley, TVA also maintains an active *Resiliency Plan* that focuses on three areas:

- Ensuring constant equipment reliability
- Monitoring, detecting and responding to physical, including extreme weather, or cybersecurity threats
- Recovering from damage if an event occurs

TVA utilizes a resilience matrix format, proposed by the North American Transmission Forum and the Electric Power Research Institute (EPRI), as a useful means of documenting high impact risks, including those stemming from climate change, and how TVA develops resilience to them. The matrix serves as a single point for analyses, emergency and operating plans, procedures, and associated publications. Additionally, it is a useful reference during emergency events, as a guideline for further improvements, and as an education source for employees.

2.0 Environmental Policy

In May 2020, the TVA Board of Directors approved the following TVA *Environmental Policy*:

> TVA improves quality of life and the environment in the Tennessee Valley by providing reliable, affordable and increasingly clean energy; engaging in proactive stewardship of the Tennessee River system and public lands; and supporting sustainable economic growth.
>
> We comply with applicable environmental laws, regulations, and commitments. We maintain an *Environmental Management System (EMS)* that fosters continuous improvement in our proactive stewardship and in reducing our environmental footprint.

The *Environmental Policy* and *EMS* are shared broadly with TVA employees. Employee awareness of TVA's *Environmental Policy* and *EMS* is essential as TVA manages climate adaptation and resiliency within its environmental management system and its environmental planning processes.

3.0 Alignment with TVA's Statement on Climate Adaptation and Resiliency

TVA manages the effects of climate change on its mission, programs and operations within its environmental management processes, risk management processes, long-term planning, and business planning processes. TVA's Environmental Policy establishes a framework to guide decision-making and future strategic development in meeting its environmental objectives.

3.1 Definitions

E.O. 13653, *Preparing the United States for the Impacts of Climate Change*, defined **adaptation** and **resilience**:

- **Adaptation** "adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects." **Adaptation is an action.** *See Chapter 28 of the Fourth National Climate Assessment (NCA4) Reducing Risks Through Adaptation Actions.*
- **Resilience** "the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions." **Resilience is a trait, capacity, or attribute**.

While **reliability** and **resiliency** are related, they are distinct in important ways:

- **Reliability:** relates to high probability, low-impact disruptions, whereas
- **Resiliency:** deals with high-impact, low-probability events. Fundamentally, resiliency is a characteristic of a system, but as a multidimensional concept, must be defined within a particular concept.

In the context of the power system, resiliency includes the ability to harden the system against high-impact, low-frequency events and quickly recover from them. Power system outages pose large financial, health and safety impacts to communities, ranging from residential units to small businesses and large corporations.

As documented in the *NCA4* Chapter 28 under Key Message 3, timescale differences further inform the distinctions recognizing that climate resilience (trait/capacity/attribute) is constructive when it upholds the capacity for climate adaptation (deliberate decisions and action(s) to adjust to climatic changes that have already occurred or are expected to occur).

TVA maintains an active Grid Resiliency Plan that focuses on three areas:

- Ensuring constant equipment reliability
- Monitoring, detecting, and responding to physical, including Table 1 *(infra)* climate threats such as extreme-weather, or cybersecurity threats
- Recovering from damage if an event occurs

As the nation's largest public utility, preparing and planning for extreme-weather events is an important part of TVA's climate adaptation and resiliency work. In addition to changes in precipitation and temperature, increases in extreme weather events may also impact the region and create challenges for TVA in maintaining the grid. A separate plan but integrated process, TVA's *Grid Resiliency Plan* demonstrates TVA's commitment to protecting the grid. Read more about TVA's grid resiliency efforts: Protecting the Grid.

3.2 Climate Adaptation and Resiliency Planning Principles

Adaptation planning is complex. There is no perfect, one-size-fits-all adaptation solution to the challenges of adapting to climate change impacts. Solutions will differ depending on context, local circumstance and scale, as well as on local culture and internal capacity. TVA continues to include the following guiding principles, consistent with previous adaptation planning guidance, for climate change adaptation and resiliency planning:

- Adopt integrated approaches
- Prioritize the most vulnerable
- Use the best available science
- Build strong partnerships
- Apply risk management methods and tools
- Apply ecosystem-based approaches
- Maximize mutual benefits
- Continuously evaluate performance

Adaptation is about managing change and, while this Plan focuses on the impact of climate on TVA, climate change is not the only factor included in TVA planning analyses. In general, TVA planners must routinely make complex decisions under uncertain conditions. Decisions made now and in the future will influence society's resilience to the impacts of future climate change. Replacement or restoration of assets to improve resilience can also be integrated into asset design and management, emergency management, hazard mitigation plans, planning project selection criteria, or environmental reviews.

4.0 Governance and Risk Management

TVA's governance structure is critical to driving sustainability performance. TVA is currently self-sustaining and self-funded and receives no public tax dollars. TVA has oversight similar to other utilities, such as a Board of Directors, credit rating agencies and the Securities and Exchange Commission (SEC) and Sarbanes-Oxley Act requirements. In

addition, TVA has oversight from Congress, the Government Accountability Office (GAO), Office of Management and Budget (OMB), the U.S. Treasury, and an independent Office of the Inspector General (OIG).

TVA's CEO-led Enterprise Leadership Team drives business strategy, including decisions relating to sustainable performance. TVA appointed an executive leader as Chief Sustainability Officer (CSO), who oversees a TVA-wide Environmental Executive Council, a Sustainability Steering Committee and a Sustainability Working Group, which together are responsible for the governance of sustainability at TVA. TVA also appointed an executive leader as Chief Risk Officer (CRO). In addition, the TVA Board established two separate Public Advisory Councils, the Regional Resource Stewardship Council and the Regional Energy Resource Council, which were formed under the Federal Advisory Committee Act to advise TVA on our stewardship activities and energy resource decisions in the Tennessee Valley region.

Enterprise Risk Management (ERM) is a strategic business function that provides TVA with a comprehensive risk perspective to more effectively identify and manage risks, capitalize on opportunities, and improve risk management behaviors. The TVA Board has established an Enterprise Risk Council (ERC) to oversee TVA's management of enterprise risks and establish an appropriate tone for a risk management culture throughout TVA. The Chief Risk Officer heads TVA's Enterprise Risk Management business unit, with responsibilities that include establishing enterprise risk management policies and guidelines as well as performing frequent risk assessments across all TVA business units.

At TVA, we work around-the-clock to monitor and protect our assets and the people of the Valley. We collaborate with other government agencies as well as industry groups and neighboring utilities. TVA business units have established continuity of operations plans and complementary emergency management policies and procedures to ensure continuity of service. We must be sure our power grid is resilient to disruptions such as cybersecurity threats, adverse weather, and atmospheric events. TVA and the LPCs support each other during times of need.

Periodic audit plans are developed using information from assurance programs and processes supporting performance incentive plans, regulatory obligations, relevant Sarbanes-Oxley (SOX) deficiencies, and business plan results. Priority of audits is based on elements such as the strength of oversight, past performance, time since changes in management, process complexity, appropriateness of risk mitigation plans, and the potential impact to the agency. Results are shared with audit and assurance groups across TVA, including the OIG and SOX. Emergent issues are considered throughout the year. To maintain readiness for future disruption, TVA has cataloged major short-term and long-term enterprise level risks, including cyber threats and those impacted by climate change, across the organization.

TVA's Chief Sustainability Officer (CSO) has overall responsibility for implementing this Climate Action Adaptation and Resiliency Plan.

Five Priority Adaptation Actions

TVA intends to continue to focus its climate adaptation and resiliency activities on these priority goals. Annual progress associated with these strategic initiatives is listed below.

Adaptation Priority Action 1. Climate Resiliency for Aquatic Species

(TVA Business Planning Strategic Initiative: Powerful Partnerships)

- **Action Description:** TVA will continue to collaborate with partners to implement TVA's *Sentinel Monitoring* (SM) and *Aquatic Ecology Management* (AEM) programs to gain a better understanding of climatic impacts on water resources and promote actions to protect aquatic resources in the Tennessee River watershed. SM and AEM are components of TVA's *Natural Resource Plan*, which align with TVA's mission and guides TVA's resource stewardship responsibilities for the future.
- **Action Goal:** Assess potential biological, ecological and hydrological responses of aquatic ecosystems related to climate change and address climate resilience opportunities.
- **Agency Lead:** TVA Natural Resources group *(Senior Specialist Water Resources)*
- **Risk or Opportunity:** Enhanced understanding of potential climate change effects on stream habitats and species biodiversity; Improved planning efforts due to the additional aquatic ecosystem data and partnership collaboration and knowledge share.
- **Scale:** Tennessee River watershed
- **Timeframe:** The SM and AEM programs and partnerships have been ongoing since FY 2014.
- **Implementation Methods:**
  - Under the SM program, TVA's *Natural Resource Plan* coordinators implement the program by selecting stream sites to monitor, establishing agreed-upon monitoring protocols, and collecting physical, chemical and biological data at stream sites located throughout the Tennessee River Watershed. Stream sites and protocols are reviewed each year and updated as needed. Key milestones include: Annual coordination with partners to monitor the selected stream sites, and analyze and share the data collected.
  - Under the AEM program, TVA participates in the Southeast Conservation Adaptation Strategy (SECAS) and communicates the findings of the SECAS information on climate resilience for aquatic habitats in coordination with Tennessee River Basin Network (TRBN). Key milestones include: Biannual meetings with SECAS to discuss strategies applicable for the Tennessee River watershed; Sharing strategies with TRBN to guide annual project planning efforts.
- **Performance**: Key metrics include: number of stream sites assessed annually; number of projects implemented to address aquatic ecosystems' climate resiliency.
- **Intergovernmental and Other Coordination:** Multiple federal and state agencies are engaged, along with non-governmental organizations (NGOs). Federal agencies: Environmental Protection Agency, National Park Service, U.S. Forest Service and U.S. Geological Survey, U.S. Fish and Wildlife. The SECAS group has participants from many federal and state agencies. NGOs: Southeast Monitoring Network and the Tennessee River Basin Network (TRBN).
- **Resource Implications**: This effort requires TVA and partnership resources and support.
- **Challenges/Further Considerations**: Stream sites must be consistently monitored to maintain robust data set to support trend analysis; partners may lose the ability to participate; additional stream sites may need to be added
- **Highlights of Accomplishments to Date**: Since 2014, TVA has worked with partners to implement over $4 million dollars in stream and aquatic habitat improvement projects in the Tennessee River watershed. These projects include the establishment of riparian buffers, removal of stream barriers, and the propagation and reintroduction of at risk fish and mussels species. TVA has also partnered with the Southeast Monitoring Network to develop standard stream monitoring protocols for sentinel monitoring and collected and shared data with collaborating agencies. Since 2015 TRBN has had annual meetings bringing federal, state, and local agencies and organizations together to share information and develop partnerships to implement projects that protect aquatic biodiversity in the Tennessee River.

Adaptation Priority Action 2. Improve Climate Adaptation and Resiliency Literacy at TVA

(TVA Business Planning Strategic Initiative: People Advantage)

- **Action Description:** This action aims to improve TVA's executive team, management and staff's understanding, integration, and use of TVA's key policies, programs, documents, and plans that support work in climate adaptation and resiliency, such as TVA's *Environmental Policy, Environmental Management System (EMS) Road Map Implementation, Sustainability Report*, and *Climate Action Adaptation and Resiliency Plan,* and the DOE Partnership Adaptation and Resiliency Framework.
- **Action Goal:** Enhance awareness and understanding of adaptation and resiliency opportunities and risks across the Agency to support increased integration and efficiencies during planning and implementation of actions.
- **Agency Lead:** TVA Environment and Energy Policy group *(Senior Program Manager Climate Policy)*
- **Risk or Opportunity:** Increasing executive team, management and staff's awareness and understanding of adaptation and resiliency risks, opportunities and related policies and plans will enable TVA to respond more effectively to climate- and resiliency-related issues.
- **Scale:** Agency-wide
- **Timeframe:** Ongoing since 2011.
- **Implementation Method:** TVA Environment and Energy Policy group will update policies, programs, documents, and plans related to climate adaptation and resiliency, and increase communication and accessibility of these items. Key milestones include: expanding TVA's *EMS,* updating TVA's *Environmental Policy*, developing a communication plan that supports climate and adaptation awareness, briefing leadership and staff on Environmental Policy, EMS Roadmap, and *Climate Action Adaptation and Resiliency Plan*, establishing monthly climate policy interdepartmental meetings of key staff; developing a TVA-wide Adaptation and Resiliency SharePoint site.
- **Performance**: Key metrics include: quarterly updates from the EMS Roadmap team, updated 2021 Plan in leadership and staff with access to the TVA SharePoint site, and monthly climate policy meetings.
- **Intergovernmental Coordination:** TVA participates in the Inter-Agency Forum on Climate Risks, Impacts & Adaptation meetings, the DOE Partnership for Energy Sector Climate Resilience, and intergovernmental adaptation and resiliency coordination groups with CEQ. Information obtained by participation is passed on within TVA by monthly Climate Policy Briefings.
- **Resource Implications:** TVA's Environment and Energy Policy group is well positioned to carry out this work.
- **Challenges / Further Considerations:** TVA will adapt efforts as climate science and policies change and will ensure leadership and subject matter experts are provided briefings and update as needed.
- **Highlights of Accomplishments to date:** TVA updated its *Environment Policy* in 2020; Initiated and completed roadmap teams to support an integrated EMS; published Corporate Sustainability report and supplemental carbon report; TVA's Board developed a Strategic Intent document that describes our efforts to implement broader clean energy for the Valley (www.tva.com/future).

Adaptation Priority Action 3. *River Management Climate Change Impact Assessment*
(TVA Business Plan Strategic Initiative: Operational Excellence)

- **Action Description:** TVA incorporates climate data and modeling assumptions with three approaches to gain insights of future potential climate and precipitation regimes, and inflow forecasting. Actions include using Current *National Climate Assessment* data to adjust TVA's long-term temperature and precipitation records to appropriately reflect the potential future climate; modeling assumptions from the RCP 8.5, the most extreme of the International Panel for Climate Change's (IPCC) scenarios to better understand the effects of increasing temperatures on load forecast; modeling the Tennessee River system to determine the most effective inflow forecasting technique with a focus on flood risk reduction, river navigation, hydroelectric power production, water supply, water quality, and recreation. These efforts are part of TVA's continued work to better understand and plan for potential climate changes that may impact the Tennessee River watershed and TVA's management of the integrated river system.
- **Action Goal:** Use modeling to understand potential impacts of temperature and precipitation changes to the river system and inflow load forecasting into TVA's reservoir system to support TVA's River Forecast Center to

make the best possible plan to meet the competing demands on the river, and enable TVA to better address this climate risk.

- **Agency Lead:** TVA River Management group *(General Manager River Management)*
- **Risk or Opportunity:** TVA is responsible for managing the Tennessee River system for multiple benefits, including navigation, hydroelectric power generation, flood damage reduction, water supply and recreation. It is critical to TVA's management of the Tennessee River system to understand how potential climate changes may affect the system and how TVA can plan and adapt to ensure a resilient system.
- **Scale:** Tennessee River Watershed
- **Timeframe**: TVA's work using the Fourth *National Climate Assessment (*NCA4) data and the inflow forecasting improvements were implemented in 2020. TVA's temperature modeling work using assumptions from the RCP 8.5 scenario began in 2020 and is ongoing.
- **Implementation Method:**
  - Current *NCA4* data (including data supporting the upcoming *Fifth National Climate Assessment (NCA5)*), will be sampled and modeled to adjust TVA's long-term temperature and precipitation records to appropriately reflect the potential future climate to continue to improve our management of the river system. Key milestones: examine model results; evaluate potential impacts; identify opportunities to incorporate findings into river management.
  - TVA will obtain a better understanding of the effects of increasing temperatures on load forecast by modeling assumptions from the RCP 8.5, the most extreme of the International Panel for Climate Change's (IPCC) scenarios. Additionally, the models estimate the effects of climate change on precipitation, estimating wetter springs, but drier summers. Key milestones: examine model results; evaluate potential impacts to TVA's operations; identify opportunities to incorporate findings into river management. The Tennessee River system will be modeled with a goal of improved understanding of how TVA will continue providing reliable river operations and electricity production for the Valley. Focus areas that will be assessed include flood risk reduction, river navigation, hydroelectric power production, water supply, water quality, and recreation. The year-long competition pits highly calibrated conceptual models, such as TVA's, against similar models from the National Weather Service and new supercomputer models from around the world. Key milestones: run the model and examine potential impacts on the focus areas; identify opportunities to incorporate findings into river management.
- **Performance:** Key metrics include: review of finding with partners; annual estimation of flood damages averted; incorporate long-term temperature and precipitation adjustment in TVA river management planning.
- **Intergovernmental Coordination:** TVA collaborated with Oak Ridge National Laboratory (ORNL) to develop and employ a model for the Tennessee River Watershed. For the IPCC scenario, the data informing the model was acquired in partnership with ORNL Climate Change Science Institute, and came from an ensemble of several supercomputer models from around the world. The National Weather Service and new supercomputer models from around the world were engaged in TVA's efforts to evaluate reliable river operations.
- **Resource Implications Existing Resources:** Continued support from TVA's River Management group is essential.
- **Challenges/Further Considerations:** While components of this work were completed in 2020, TVA continuously seeks information and understanding of changes that could affect the Tennessee River system and TVA's management.
- **Highlights of Accomplishments to date:** TVA formed strong partnerships with ORNL to share resources; Incorporated national climate assessment data into TVA's modeling to more accurately reflect potential changes.

Adaptation Priority Action 4: Flood Hazards and Water Reliability

(TVA Business Plan Strategic Initiative: Igniting Innovation)

- **Action Description:** TVA is examining potential flooding events and water reliability risks to support TVA's mission and carry out its responsibilities in managing the Tennessee River system. TVA has modeled flood events and water supply using various techniques in the past; however, these studies were initiated in 2020.
- **Action Goal:** The goal of the flood event modeling process is to utilize information much richer than what TVA has had access to in the past in order to help TVA improve decisions on where and how to invest to reduce flood risk the most. The water reliability study helps TVA increase our reservoir operation resilience.
- **Agency Lead:** TVA River Management group (General Manager River Management)
- **Risk or Opportunity:** The projects help TVA address the resiliency risk of increased flooding predicted in some climate models and address the climate opportunity of testing the resilience of our policies and intake equipment against the largest historical droughts we can find.
- **Scale:** Tennessee River Watershed
- **Timeframe:** Implemented in 2020.
- **Implementation Method:**
  - TVA is utilizing a state-of-the-art stochastic flood event model to create thousands of realistic extreme floods. These floods are routed through TVA's reservoir operation model to determine the effect they would have on TVA's infrastructure as well as other infrastructure built near the river. Statistical techniques built into the software allow us to understand the likelihood of these events, as well as the magnitude. Key milestones include: evaluating the model results; identifying opportunities to incorporate information into planning.
  - A 600-year reconstruction of rainfall within the TVA watershed (based on tree ring analysis) has been routed through TVA's reservoir operation model to determine the effect on TVA's infrastructure, as well as other infrastructure built near the river. Testing the system against extended droughts will help TVA prepare appropriately should climate change lead to such a drought. Key milestones include: evaluating the model results; identifying opportunities to incorporate information into planning.
- **Performance:** Key metrics include: flood damage averted; infrastructure flood resilience; improved resilience of TVA's reservoir operations; improved resilience of operations of the water utilities and industries that rely on us for water.
- **Intergovernmental and Other Coordination:** TVA collaborated with the ORNL on the flood hazard work and partnered with the University of Tennessee on the water reliability study.
- **Resource Implications:** TVA staff and partnership involvement will be important for future work.
- **Challenges / Further Considerations:** Increases or changes in infrastructure, and changes in surrounding land use and population may require adjustments to modeling assumptions.
- **Highlights of Accomplishments to date:** Through the water reliability study, TVA gained information on the largest historical droughts and can use that information to test the resiliency of TVA's management policies.

Adaptation Action 5 Activities: Investing in the Future while Keeping Energy Costs as Low as Possible
(TVA Business Plan Strategic Initiative: Financial Strength)

- **Action Description:** TVA maintains a 10-year Financial Plan with the goal of investing in the future while keeping energy costs as low as possible through efficient execution of the plan. Through our financial planning, TVA carries out its mission of providing low-cost, reliable electricity while protecting the environment and supporting a prosperous economy. This means that as we take steps to address climate change and increase resiliency, we are considering potential environmental, social and economic impacts of our actions.
- **Action Goal:** Maintain adequate budget and staff to support the implementation of climate adaptation, mitigation, and resiliency actions, and ensure cost burdens of these actions are not added to vulnerable or low wealth populations.
- **Agency Lead:** TVA Financial Services (Chief Financial and Strategy Officer)
- **Risk or Opportunity:** The financial plan addresses climate resiliency risk through adequate allocation of funding for adaptation and resiliency programs and staff.

- **Scale:** Agency-wide
- **Timeframe:** Current iteration covers the 2020-2030 timeframe.
- **Implementation Method:** TVA will craft five-year business plans that align with the 10-year financial plan. TVA will implement programs and projects as part of its five-year business plan that address climate adaptation and resiliency while adhering to its mission. Key milestones include: development of a five-year business plan; development of annual metrics to track progress.
- **Performance:** Key metrics include: Agency-wide annual performance metrics on budget adherence and business plan actions; as well as metrics tracked through the OMB scorecard process.
- **Intergovernmental and Other Coordination:** OMB, Council on Environmental Quality (CEQ); The battery demonstration project will be produced in coordination with ORNL and the Electric Power Research Institute (EPRI).
- **Resource Implications:** Since 1999, TVA has funded all of its operations almost entirely from the sale of electricity and power system financings.
- **Challenges / Further Considerations:** Changes in the economy, and changes surrounding customer and investor strategies may require adjustments to assumptions. The financial plan addresses climate resiliency risk through adequate allocation of funding for adaptation and resiliency programs and staff. TVA will need to continue allocating proper funding while maintaining low cost energy and supporting our mission.
- **Highlights of Accomplishments to date:**
  - Within TVA's statutory least cost planning mandate, we are an electric utility industry leader in carbon emission reductions in our electricity generating fleet while maintaining high reliability and low cost; through CY2020, TVA has a 63% reduction in our mass emissions since 2005. TVA's Board developed a Strategic Intent document that describes our efforts to implement broader clean energy for the Valley (www.tva.com/future).
  - TVA has established carbon emission goals for the electricity we provide to the Valley: from a 2005 baseline, we have a plan to achieve 70% reduction by 2030, a path to about 80% reduction by 2035, and an aspiration to be net-zero by 2050. TVA also published its Sustainability Report and supplemental Carbon Report, outlining TVA's plans to invest in the region and clean energy, while keeping energy costs as low as possible.
  - Battery storage is one example of projects TVA is initiating to address climate change while maintaining low-cost reliable power. TVA has implemented a battery storage demonstration project at Vonore, Tennessee, that will come online in 2022. It will be TVA's first owned and operated grid-scale battery energy-storage system, a 20 megawatt, 40 megawatt-hour demonstration system through 2038. The project aims to ensure continued electrical reliability for up to 14 gigawatts of solar energy planned, while improving grid reliability and resiliency.

Topic 1: Update Climate Vulnerability Assessments

The goal of TVA's *Climate Action Adaptation and Resiliency Plan (Plan)* and its planning process are "to ensure the Agency continues to achieve its mission and program goals, and to operate in a secure, effective and efficient manner in a changing climate." Consistent with CEQ guidance, this *Plan* leverages TVA's previous climate vulnerability assessments and identifies the five vulnerabilities directly tied to management function, as well as decision points for managing procurement, real property, public lands, waters, and financial programs.

Table 1 summarizes the key high-level adaptation risks and opportunities to TVA's mission, programs, and operations in the short- and long-term, and where these risks and opportunities are disclosed. The risks and

opportunities analyzed are within the ranges considered by TVA's current planning and evaluation processes utilizing the *DOE Partnership Climate Adaptation and Resiliency Planning Framework* presented in Figure 1.

Conducting vulnerability assessments and developing resilience solutions within TVA planning processes are usually iterative. Information gathered on assets may inform climate information needs and vice versa. Users should follow the steps in the sequence presented, as each step builds on the previous one. However, as more information becomes available during this process, users may find it helpful to repeat entire or individual parts of previous steps to more effectively inform the overall TVA planning process.

Table 1. High-Level Vulnerability Assessment Summary

Vulnerability	Climate Threat	Potential Short Term and Long Term Expected Impact	Determined Adaptation Action, Including Known Barriers to Implementation; Timeline and Measures	Analysis and Disclosure: Procurement	Real Property	Public Lands	Waters	Financial	Programs
Electricity Demand	Temperatures are rising in all regions, and these increases are expected to drive greater use of air conditioning. The increase in annual electricity demand across the country for cooling is offset only marginally by the relatively small decline in heating demand that is met with electric power. CDDs are projected to increase while HDD decrease. Cooling degree days (a measure of the need for air conditioning [cooling] based on daily average temperatures rising above a standard temperature— often 65°F) nearly double, while heating degree days (a measure of the need for heating) decrease by over a third. The freeze-free season lengthens by more than a month, and the frequency of freezing temperatures decreases substantially.	Sixty-one percent of large Southeast cities are exhibiting some aspects of worsening heatwaves, which is a higher percentage than any other region of the country. Changes in winter air temperature patterns are one aspect of climate change that will play an especially important role in the Southeast. Investing in increased cooling is one likely form of adaptation. Among U.S. regions, the Southeast is projected to experience the highest costs associated with meeting increased electricity demands in a warmer world. Under the higher scenario, nighttime minimum temperatures above 75°F and daytime maximum temperatures above 95°F become the summer norm and nights above 80°F and days above 100°F, now relatively rare occurrences, become commonplace.	**Climate Sensitive Demand Forecast:** Load forecasting included a climate change scenario to model the effects of increasing temperatures on the load forecast. Assumptions were modeled from the RCP 8.5--the most extreme of the IPCC's scenarios-- using data acquired through partnership with ORNL's Climate Change Science Institute. This data came from an ensemble of several supercomputer models from around the world. Under the RCP 8.5 scenario, TVA's region would see more warming at nighttime and in the winter. These increased temperatures would translate to about 1% higher annual winter energy and about 2% lower annual winter peaks. Additionally, the models estimate the effects of climate change on precipitation, predicting wetter springs, but drier summers. Additional work will model how climate change impacts other parts of TVA's business.	SEC Reporting	SEC Reporting	Natural Resource Plan, SEC Reporting	IRP, Business Plan, SEC Reporting	IRP, Annual Business Planning, SEC Reporting	
Thermoelectric Power Generation	Higher temperatures reduce the thermal efficiency and generating capacity of thermoelectric power plants. The efficiency and current carrying capacity of transmission and distribution lines are also reduced at higher temperatures.	Warmer air temperatures will result in warmer water. Warmer water holds less dissolved oxygen, making instances of low oxygen levels more likely. TVA continually monitors and uses several methods to regulate and has ongoing programs to maintain Dissolved Oxygen and water temperatures to ensure minimal impacts to receiving streams and aquatic life.	**River Management Climate Change Impact Assessment**: TVA works to assess the possible climate impacts on the Tennessee River system, utilizing national climate data. The National Climate Assessment (NCA5) data will be sampled and modeled to adjust TVA's long-term temperature and precipitation records to appropriately reflect the potential future climate. The river system will be modeled to better understand how TVA will continue providing reliable river operations for the Valley. Focus areas that will be assessed in the Assessment are flood risk reduction, river navigation, hydroelectric power production, water supply, water quality, and recreation.	SEC Reporting	SEC Reporting	Natural Resource Plan, SEC Reporting	IRP, Business Plan, SEC Reporting	IRP, Annual Business Planning, SEC Reporting	

Vulnerability	Climate Threat	Potential Short Term and Long Term Expected Impact	Determined Adaptation Action, Including Known Barriers to Implementation; Timeline and Measures	Procurement	Real Property	Public Lands	Waters	Financial Programs
Hydroelectric Power Generation	Warmer air temperatures will result in warmer water. Warmer water holds less dissolved oxygen, making instances of low oxygen levels more likely. The efficiency and current carrying capacity of transmission and distribution lines are also reduced at higher temperatures.	Warmer air temperatures will result in warmer water. Warmer water holds less dissolved oxygen, making instances of low oxygen levels more likely. The NCA4 concluded that while some hydropower facilities may face water-related limitations, these could be offset to some degree by the use of more efficient turbines as well as innovative new hydropower technologies. TVA continually monitors and uses several methods to regulate and has ongoing programs to maintain Dissolved Oxygen (DO).	**Inflow Forecasting Improvements***:* TVA is partnering with hydro operators throughout North America to hasten the next evolution of river inflow modeling. Accurate forecasting of the flows coming into TVA's reservoir system allows our River Forecast Center to make the best possible plan to meet the competing demands on the river. TVA and several other partners are participating in a yearlong inflow forecasting competition to determine which techniques provide the best inflow forecast over a wide range of conditions and geographies. The competition pits highly calibrated conceptual models such as TVA's against similar models from the National Weather Service, a new supercomputer model run at the National Water Center, and artificial intelligence models created by tech startups. The industry is closely watching the competition, and the results are sure to deeply influence the evolution of operational river forecasting for years to come. TVA plans to act on the intelligence gathered to continue our improvement in managing the river system.	SEC Reporting	SEC Reporting	Natural Resource Plan, SEC Reporting	IRP, Business Plan, SEC Reporting	IRP, Annual Business Planning, SEC Reporting

Vulnerability	Climate Threat	Potential Short Term and Long Term Expected Impact	Determined Adaptation Action, Including Known Barriers to Implementation; Timeline and Measures	Procurement	Real Property	Public Lands	Waters	Financial Programs
Increased Flooding	A changing climate, particularly in areas projected to be warmer and drier, is expected to lead to drought and stresses on water supply, affecting energy, water, and land sectors in the United States.	Downpours can trigger sewage overflows and lead to contaminated drinking water. The NCA4 reports that few studies have projected the impacts of climate change on nitrogen, phosphorus, sediment, or dissolved organic carbon (DOC) transport from land to rivers. However, given the tight link between river discharge and all of these potential pollutants, the NCA4 concludes areas of the U.S. that are projected to see increases in precipitation, and increases in intense rainfalls, may experience water quality challenges.	**Probabilistic Flood Hazard Analysis:** In these studies, TVA utilizes a state-of-the-art stochastic flood event model to create thousands of realistic extreme floods. These floods are routed through TVA's reservoir operation model to determine the effect they would have on TVA's infrastructure as well as other infrastructure built near the river. Statistical techniques built into the software allow us to understand the likelihood of these events as well as the magnitude. This information is much richer than the information that TVA has utilized in the past and is allowing TVA to improve decisions on where and how to reduce flood risk the most. The project helps TVA address the resiliency risk of increased flooding predicted in some climate models.	SEC Reporting	SEC Reporting	Natural Resource Plan, SEC Reporting	IRP, Annual Business Planning, SEC Reporting	IRP, Annual Business Planning, SEC Reporting
Extreme Weather Events	The principal contributor to power outages, and their associated costs, in the United States is extreme weather. Severe weather can have a negative impact on energy infrastructure, posing physical and operational threats to grid components.	The NCA4 reported that, since 1980, the Southeast has had more billion-dollar weather disasters (hurricanes, floods, and tornadoes) than any other region in the United States. The frequency of extreme-precipitation-events has increased across the Southeast, particularly over the last two decades. For example, the number of days with 3 or more inches of precipitation has been historically high over the past 25 years, with the 1990s, 2000s, and 2010s ranking as the decades with the 1st, 3rd, and 2nd highest number of events, respectively. More than 70% of precipitation recording locations show upward trends since 1950, although there are downward trends at many stations along and southeast of the Appalachian Mountains. The number of days with heavy precipitation has increased at most stations, particularly since the 1980s.	**Battery Storage Demonstration Project:** To manage resiliency and reliability with increased renewable energy on the system, TVA has a battery-storage demonstration project at Vonore, Tennessee, that will be online in 2022. This project will help us understand how best to utilize batteries for balancing renewables and optimizing the transmission system. These learnings will help us effectively plan for the future grid. TVA's first owned and operated grid-scale battery energy-storage system, a 40 megawatt-hour demonstration system, will help ensure continued electrical reliability for up to 14 gigawatts of solar energy planned through 2038. The Vonore Battery Energy Storage System is due to be operational in late 2022.	SEC Reporting	SEC Reporting	Natural Resource Plan, SEC Reporting	IRP, Annual Business Planning, SEC Reporting	IRP, Annual Business Planning, SEC Reporting

Vulnerability	Climate Threat	Potential Short Term and Long Term Expected Impact	Determined Adaptation Action, Including Known Barriers to Implementation; Timeline and Measures	Procurement	Real Property	Public Lands	Waters	Financial Programs
Transmission	Warmer air temperatures reduce capacity of transmission lines and increase potential for clearance limit (sagging) losses increase as conductor temperature is proportional to electrical resistance. Persistent high temperatures may reduce the life expectancy of transformers.	NCA4 concludes the frequency of extreme heat events has increased and will continue to increase. Bartos (2016) estimates summertime transmission capacity could be reduced roughly 2 to 6% by 2050. Transformer capacity has been estimated to decrease 0.7% for every 1 degree C above 30 degrees C.	**Documenting high impact risks:** A resilience matrix format proposed by the North American Transmission Forum and EPRI has been adopted as a useful means of documenting high impact risks and how TVA develops resilience to them. The matrix serves as a single point for analyses, emergency and operating plans, procedures, and associated publications and is a useful reference during emergency events as well as a guideline for further improvements and an education source for employees.	SEC Reporting	SEC Reporting	Natural Resource Plan, SEC Reporting	IRP, Annual Business Planning, SEC Reporting	IRP, Annual Business Planning, SEC Reporting

Topic 2: Describe Agency Efforts to Enhance Climate Literacy in Its Management Workforce

1.0 Improve Executive Team Understanding of Climate Adaptation and Resiliency

TVA continues to improve executive team understanding of the *Environmental Policy, Environmental Management System (EMS) Road Map Implementation, Sustainability Report*, and *Climate Action Adaptation and Resiliency Plan.* We continue to review alignment and understanding, including a common adaptation and resiliency analytical framework. This strategy was developed to address the climate risk that executives may not adequately understand adaptation and resiliency concerns. Its Agency lead, Environment and Energy Policy, seeks to implement improved understanding by updating the *Environmental Policy*, *EMS* and *Climate Action Adaptation and Resiliency Plan (Plan)*.

2.0 Improve Climate Adaptation and Resiliency Literacy at TVA

TVA aims to achieve familiarity and common use of this *Plan* and *DOE Partnership Climate Adaptation and Resiliency Framework* through monthly climate policy interdepartmental meetings of key staff and a TVA-wide Adaptation and Resiliency SharePoint collaboration site. The strategy is designed to ensure TVA staff adequately understand adaptation and resiliency risks or opportunities and provide TVA staff with opportunities to collaborate and easily share information with each other.

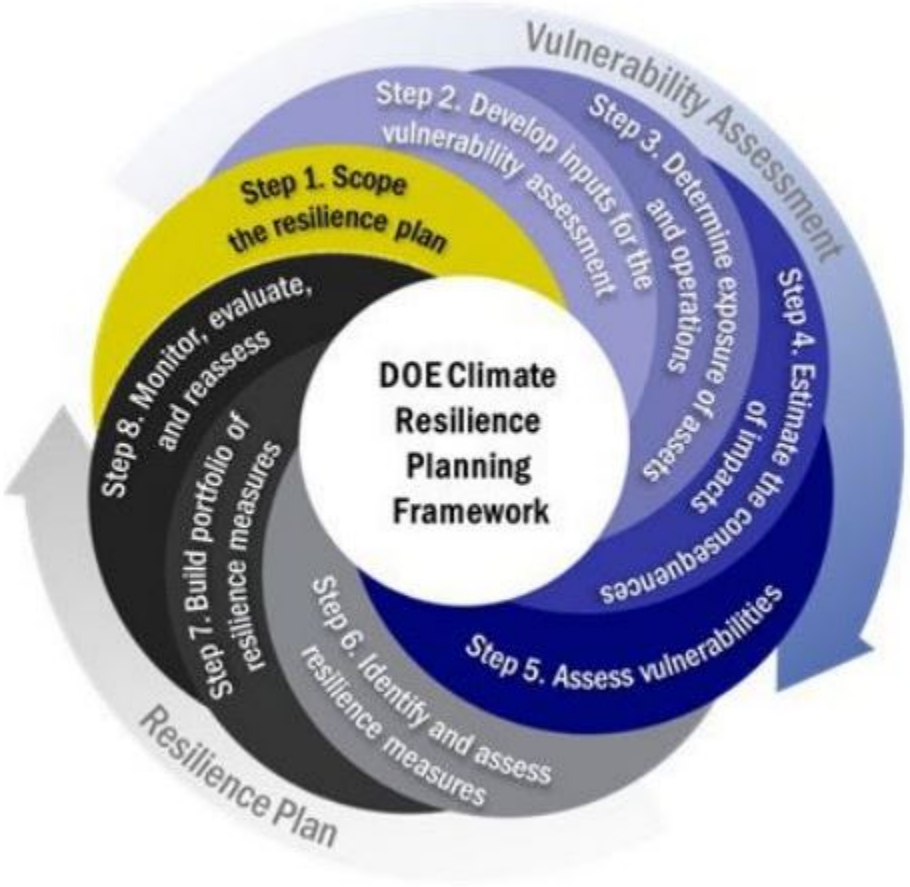
3.0 Climate Adaptation and Resiliency Planning Framework

TVA continues its efforts to ensure climate change adaptation and resiliency are integrated into both agency-wide and regional planning efforts, in coordination with other federal agencies as well as state and local partners, Tribal governments and private stakeholders. The guidance presented in this *Plan* is intended to be consistent with applicable voluntary *DOE Partnership for Energy Sector Climate Resilience* guidance for electric utilities. Any specific risks considered and further analysis required will be determined by the applicable Agency planning process and will vary by location and asset mix.

The *DOE Partnership Climate Adaptation and Resiliency Planning Framework (Planning Framework)* is a three-part process:

1. **Defining the scope**, of which the identification of goals is a critical process starting point.
2. **Completing the vulnerability assessment**, which involves determining where and under what condition the system is vulnerable.
3. **Developing the resilience plan**, to improve resilience-based information generated or assembled during the vulnerability assessment, including the probability of adverse climate events and potential climate threshold conditions likely to affect important assets or overall system performance, and the consequences of costs of climate impacts.

Figure 1. Planning Framework



The *Planning Framework* provided in this Plan is intended to equip TVA planners with the analytical framework, references, tools and other guidance to:

1. Understand how to consider climate change in their plans and projects--including guidance on how to use climate projections that involve multiple future scenarios and different time periods in planning and project designs.

2. Consider both short-and long-term vulnerabilities and balance tradeoffs.

With each *Plan* update, TVA continues to improve its climate action and resiliency planning efforts with more detailed and updated information on stakeholder concerns, management objectives, resource availability (natural, human and financial), science and technology and other dynamic factors. Ongoing efforts to address gaps in data, methodologies, tools and other resources are underway at TVA and at academic, government, and industry organizations across the country. Continued communication, data sharing, and coordination on research best practices, resilience solutions and needs will continue to help leverage resources, strengthen knowledge and projections, and improve resilience.

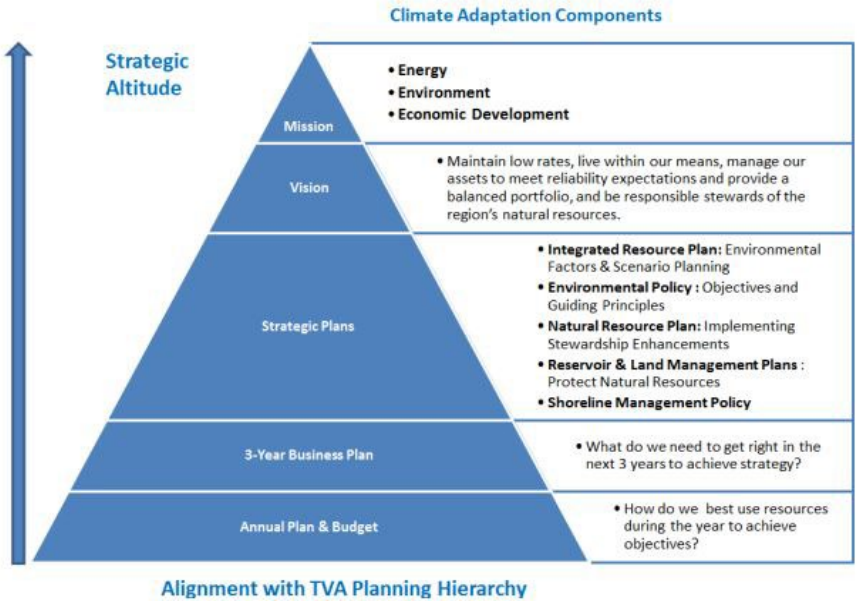
Climate change adaptation planning will help TVA:

- Identify how climate change may impact TVA's ability to achieve its mission, operate its facilities efficiently and meet its policy and program objectives
- Assess the potential consequences of climate change and the ability to mitigate negative impacts through adaptation and other opportunities
- Develop, prioritize, implement and evaluate adaptation planning actions, as practicable, to moderate climate change risks and exploit new opportunities influenced by climate change
- Ensure its resources are invested wisely, and its services and operations remain effective in future conditions
- Contribute to the Federal government's leadership role in sustainability and pursue the vision of a resilient, healthy, and prosperous Nation, in the face of a changing climate.

4.0 TVA's Major Environmental Planning Processes

TVA's climate adaptation and resiliency planning activities are summarized in Figure 2.

Figure 2: Climate Adaptation and Resiliency Planning Is Integrated Into TVA's Planning Hierarchy



5.0 Climate Adaptation and Resiliency Metrics

The standardization of metrics for other power system characteristics such as reliability has enabled streamlined and widespread adoption across the industry. Unlike reliability metrics, there are currently no established or agreed-upon resiliency metrics. Despite growing concern over the critical need to address resiliency, a 2018 EPRI study concluded current resiliency efforts and analytical frameworks are diverse and lack a unifying perspective, i.e., there is currently no standardized framework for assessing resiliency levels or evaluating investment options.

Topic 3: Describe Agency Actions to Enhance Climate Resilience

TVA is exposed to a wide range of high-impact events. The Department of Homeland Security has identified 16 critical U.S. infrastructure sectors as highly dependent upon electricity. These critical infrastructures are:

- Chemical;
- Commercial facilities;
- Communications;
- Critical manufacturing;
- Dams;
- Defense industrial base;
- Emergency services;
- Energy;
- Financial services;
- Food and agriculture;
- Government facilities;
- Healthcare and public health;
- Information technology;
- Nuclear reactors, materials and waste;
- Transportation systems;
- Water and wastewater systems.

All of these infrastructures are among TVA's own assets, or are our directly-served customers or customers of our local power companies.

Resilient utilities:

- Coordinate with the operators of these infrastructures before and during extreme events to ensure that as many infrastructure services as possible are provided to as many people as possible.
- Operate in a manner that reduces risk, especially in immediate preparation for and response to disruption.
- Shift the objective of operations during extreme events away from cost and reliability, and toward response and recovery in a manner that contributes to long-term resilience.
- Enable operations to work in tighter coordination with advanced technologies in order to improve situational awareness and human decision making during major disruptions.

Climate adaptation and resiliency planning can be complex. Solutions will differ depending on context, local circumstance, and scale, as well as on local culture and internal capacity. Where changing external conditions affect planning decisions, planners should seek to understand, monitor, and adapt to these changes--including changes in extreme weather and climatic conditions such as temperature, rainfall patterns, storm frequency and intensity, and water levels. Weather effects associated with climate change represent budgetary risk. Adaptation and resiliency planning can reduce potential service interruptions, equipment damage, and associated costs. While no individual

weather event can be definitely linked to climate change, particular weather events can demonstrate vulnerability of TVA facilities.

A. Describe Agency Actions for Climate-Ready Sites and Facilities

In 2020, TVA updated its *Natural Resource Plan* (NRP), a strategic-level document that guides the direction of TVA's resource stewardship on TVA public lands and throughout the region. The NRP supports TVA's sustainability efforts by creating a framework to balance land use, human activity, and resource protection in order to achieve the greatest public benefit. This past year, TVA collaborated with more than 160 partnership organizations to implement 245 projects aligned with the NRP objectives.

As a Federal agency, TVA must also comply with the *National Environmental Policy Act (NEPA)*, as well as applicable *Executive Orders*, such as *EO 14008*, *Tackling the Climate Crisis at Home and Abroad*. Environmental goals are an integral part of how TVA does business and are tracked along with its other business objectives.

Consistent with TVA's *Climate Action Statement on Adaptation and Resiliency*, each TVA major planning process identifies significant climate change risks. Significant climate change risks are those identified risks with the potential to substantially impair, obstruct, or prevent the success of agency mission activities, both in the near-term and particularly in the long-term, using the best available science and information. This identification includes:

- A brief statement of the rationale for classifying the risk as significant
- Factors considered in the review
- Any actions the Agency believes may decrease the threat of the potential risk
- The identification of any relevant milestones and responsible agency components or offices
- Whether the action can be addressed exclusively by the agency, or if stakeholders need to be involved.

Risks are also identified through:

- Annual strategic planning;
- Annual risk review and enterprise risk management (ERM);
- Transmission reliability and resiliency planning;
- Grid-X national grid resiliency exercise;
- FEMA national dam safety/USCG exercise;
- Asset hardening for extreme weather;
- Lessons learned after extreme events;
- Corrective action program;
- Fukushima related hardening;
- Revised design basis for TVA dams based on updated probable maximum flood calculations;
- Partnerships with other federal entities like NWS, USACE, DHS, FEMA;
- Cybersecurity efforts;
- NERC reliability standards and annual winter/summer reserve modeling

For further discussion of risk, see Item 1A, Risk Factors in TVA's Annual Report on Form 10-K. GSA has also provided a sustainable facilities tool to assist with adaptation and resiliency analysis for federal facilities operations and maintenance.

B. Describe Agency Actions to Ensure a Climate-Ready Supply of Products and Services

TVA has begun a carbon inventory of its supply chain. This *Plan* will provide an accounting framework for additional supply chain adaptation and resiliency analysis to further inform TVA's *Resiliency Plan* of potential climate-related risks and sensitivities. A carbon intensity evaluation by purchased product category and commodity analysis has been completed.

Critical supply chains should achieve resilience objectives comparable to those TVA has established for itself, including resilience procurement criteria, incentives for improved supplier performance, and the facilitation of the disclosure of suppliers' resilience performance information. Several aspects of supply chain structure should be used for supply chain characterization, including:

- Prevalence of single source suppliers (at all supply chain tiers);
- Redundancies (additional facilities, additional buffer inventories and stocks, additional capacity);
- Flexibility (of sourcing, transport systems, etc.);
- Responsiveness (how quickly can the supplier respond based on their governance, business continuity plans in place, etc.);
- Proximity of distribution (in the event of physical disruptions, such as storm damage limiting transportation infrastructure);
- Other parameters are being added for increased risk monitoring including pandemic, cyber, foreign components, and carbon intensity management.

GSA has also provided additional Supply Chain Climate Risk Management Framework guidance as shown in Figure 3.

Figure 3. Supply Chain Risk Management Framework.