CLIMATE CHANGE ADAPTATION ACTION PLAN

Executive Order 13514
Federal Leadership in Environmental, Energy, and Economic Performance

Executive Order 13653
Preparing the United States for the Impacts of Climate Change



TVA Statement on Climate Change Adaptation

TVA is a wholly-owned corporate agency of the United States. In 1933, Congress charged TVA with improving the quality of life in the Tennessee Valley region through the integrated management of the region's resources. As part of its regional resource mission, TVA operates the Nation's largest public power system and manages the Tennessee River and its tributaries. Congress has directed TVA to provide low-cost, reliable electricity, promote economic development, foster environmental stewardship, and stimulate technological innovation. As times changed, TVA changed with them, meeting new challenges and bringing new opportunities. Today, we continue to serve the people of the Tennessee Valley through work in three areas: Energy, the Environment and Economic Development.

- **Energy: Provide Affordable Electric Power Throughout the Tennessee Valley Region**
  TVA supplies reliable, affordable electricity to the Tennessee Valley region. It strives to meet the changing needs of local power companies and directly served industrial and federal customers for electricity and related products and services in a dynamic marketplace.

- **Environment: Act As A Steward of the Valley's Natural Resources**
  TVA is tasked with the wise use and preservation of the region's natural resources. It manages the Tennessee River system and associated public lands to reduce flood damage, maintain navigation, support power production and recreational uses, improve water supply and air quality, protect shoreline, and cultural and historical resources.

- **Economic Development: Serve as a Catalyst for Sustainable Economic Development**
  TVA works with local power companies; state, regional, and local economic development organizations; and federal agencies to build partnerships that help bring jobs to the Tennessee Valley and make the economy stronger to benefit the people of the region.

The TVA region encompasses 80,000 square miles in parts of seven southeastern states and TVA's power system serves the electrical needs of 9 million people. TVA is governed by a nine-member Board of Directors appointed by the President. TVA's power system and all stewardship activities have been self-funded since 1959 and 1999, respectively. TVA receives no appropriations.

TVA issued its initial Statement on Climate Change Adaptation in June 2011 and has applied it to its ongoing activities. This statement changes the format of that earlier statement and updates it.

TVA maintains its *Climate Change Adaptation Plan* as a cohesive part of its major planning processes--including integrated resource management, natural resource, and National Environmental Policy Act (NEPA) planning. As appropriate, TVA applies applicable Executive Orders (EO); such as, EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, and EO 13653, *Preparing the United States for the Impacts of Climate Change* as well as all guiding principles and planning frameworks and guidance complementary to these Orders.

While the scope, severity and pace of future climate change impacts are difficult to predict, climate change adaptation planning allows TVA to:

- identify possible impacts to mission achievement;
- assess potential consequences and ability to mitigate climate change;
- develop adaptation planning actions;
- ensure resources are invested wisely; and,
- support the Federal Government's leadership role in sustainability.

June 23, 2014

Specifically, Our *Climate Change Adaptation Plan* identifies:

- how climate change may impact TVA's ability to achieve its mission;
- ways the Agency can prioritize and measure its progress and its capability to adapt to current and future changes in climate;
- 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's major planning processes, consistent with its *Climate Change Adaptation 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 Change Adaptation Plan*, in a manner appropriate for the process used.

As appropriate, TVA will coordinate with other agencies and interagency efforts, including the Interagency Climate Change Adaptation Task Force, on climate change adaption issues that cut across agency jurisdictions.

TVA plans to update and revise its *Climate Change Adaptation Plan* within one year of the quadrennial publication of the *National Climate Assessment*.

Adaption Planning Coordination and Implementation and Delegations

TVA's Vice President Environment and Senior Sustainability Officer (SSO) is responsible for ensuring implementation of all aspects of this statement, periodic reviews and updates to confirm it remains relevant. This statement does not alter nor affect any existing duty or authority of individual TVA business units.

Through this statement, development and implementation of TVA's *Climate Change Adaptation Plan* is guided by TVA's Environment Group, the point of contact with the Office of Management and Budget (OMB) and Council on Environmental Quality (CEQ) on sustainability reporting. TVA's Environment Group leads TVA's Adaptation Planning Program and governance structure which includes subject matter experts and representatives from multiple business units that work together with TVA's Sustainability Program to provide leadership and focus for TVA's adaptation efforts.

TVA's VP Environment and SSO delegates authority to Business Unit Leaders and Representatives tasked with aligning adaptation planning goals and initiatives with their annual business planning process. Alignment with business planning ensures that resources are used most efficiently and opportunities to maximize sustainability benefits are identified and realized.

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

Approval of TVA Statement on Climate Change Adaptation

Approved: William D. Johnson	Chief Executive Officer

June 23, 2014

TVA Climate Change Adaptation Action Plan

A. TVA'S CLIMATE CHANGE ADAPTATION POLICY FRAMEWORK

The goal of TVA's adaptation planning process is 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."[i] TVA has, in accordance with the requirements of E.O. 13514, *Federal Leadership in Environmental, Energy and Economic Performance*[ii] and E.O. 13653, *Preparing the United States for the Impacts of Climate Change,*[iii] adopted an internal statement on climate change adaptation to establish an adaptation planning goal and to better understand the challenges and opportunities a changing climate may present to its mission and operations.

TVA manages the effects of climate change on its mission, programs, and operations within its environmental management processes. Its primary planning processes are its *Integrated Resource Plan (IRP)* and its *Natural Resource Plan (NRP)*. As a Federal agency, TVA must also comply with the National Environmental Policy Act (NEPA); as well as, applicable Executive Orders, such as E.O. 13514 and E.O. 13653. Environmental goals are an integral part of how TVA does business and are tracked along with its other business objectives. TVA has completed a high-level climate change vulnerability assessment as required by E.O. 13514. TVA's adaptation planning activities are summarized in **Figure 1** and **Figure 2**. Adaptation Projects are summarized in **Table 1**.

Figure 1: Climate Adaptation Planning Is Integrated Into TVA's Planning Hierarchy

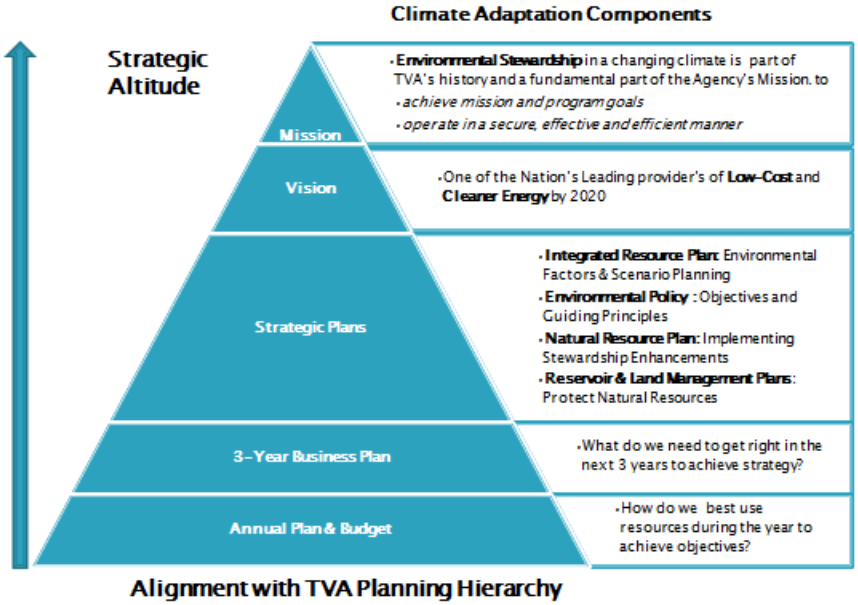

Figure 2: Climate Adaptation Planning As Integrated Into TVA's Planning Processes

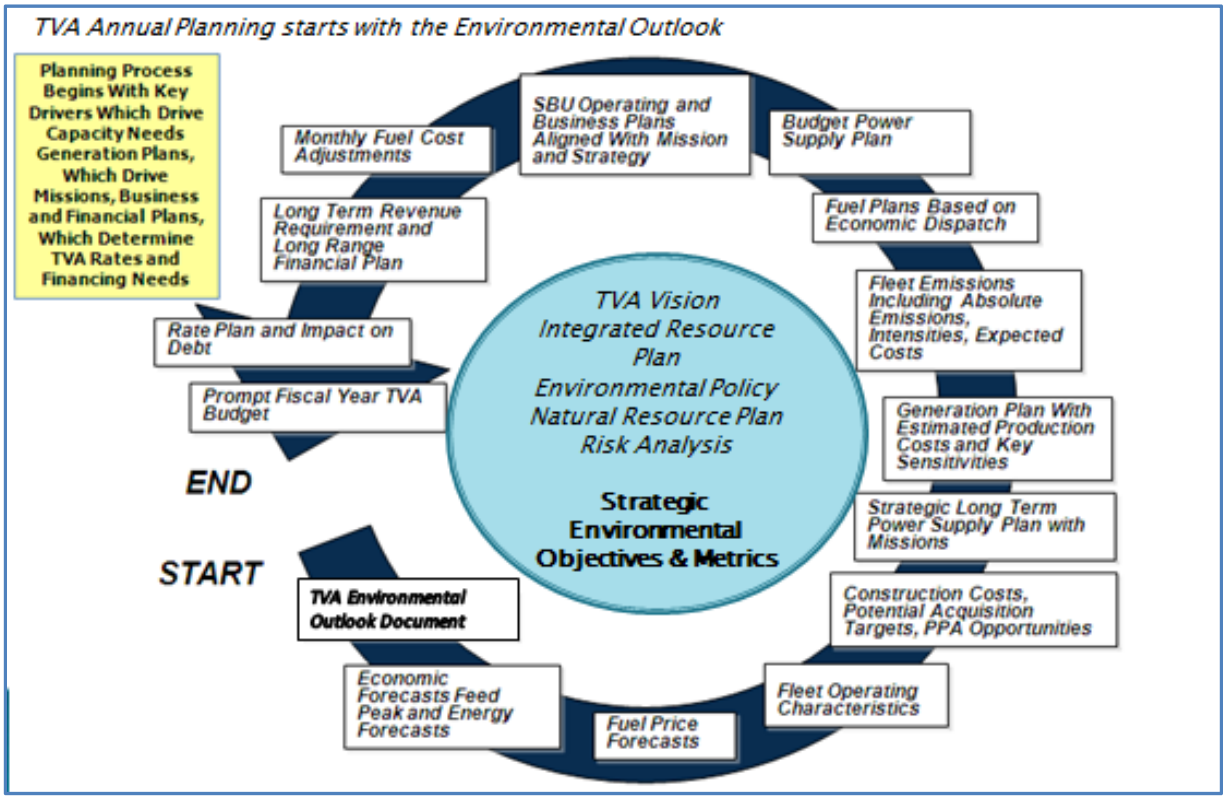

Table 1: Current Climate Adaptation Projects

Project	Description	Action Goals	Performance
Climate Sentinel Monitoring	This project is listed in TVA's Natural Resource Plan (NRP) and focuses on collecting biological, chemical, and physical data in each of the five predominant eco-regions in the Tennessee Valley.[iv]	Collect baseline data to assess and analyze potential biological, ecological and hydrological responses of aquatic ecosystems to climate change.	Annual Report
Aquatic Ecology Management	This project is listed in TVA's NRP and focuses on the enhancement of aquatic biological communities in TVA streams, reservoirs and tailwaters. This may include activities such as habitat improvements, biological monitoring and pollution reduction.	• A stronger understanding of factors affecting aquatic habitats and biological communities • Protection and improvement of aquatic habitats and biological communities • Increased knowledge and protection of threatened and endangered species • Improved public awareness and land use impacts and a potential for invasive species (e.g. foreign species transported into habitats)	Annual Report

		• Strengthened relationships with existing and new partners • Expanded collaborative efforts (funding and resources) to better evaluate and protect exceptional biodiversity within the Tennessee River watershed • Increased recognition of exceptional "hot spots" of biological diversity within the Tennessee River and watershed and TVA's commitment to partnering on improvement and protection efforts.	
Stream and Tailwater Monitoring Program	This project is listed in TVA's NRP and uses biological monitoring to evaluate biological conditions and diversity that reflect watershed conditions. This information is used for decision making by water resource managers throughout the Tennessee River Valley (e.g. states, TVA, etc.) to target and track improvements. Also, it helps create public awareness about water resource conditions, increasing the opportunity for water resource managers to become involved in monitoring and data collection activities. Data gathered through stream and tailwater monitoring are used to measure certain effects below dams and to track operations changes resulting from the Reservoir Operations Study (2004). The primary biological monitoring tool is the Index of Biological Integrity for fish communities. This methodology is used to identify both healthy and unhealthy streams and also to target and track success of stream improvement projects.	• A proficient understanding of stream and tailwater conditions • Ability to make more informed watershed management decisions • Targeted and tracked watershed and tailwater improvement efforts • Additional support for state and TVA programs separate from the NRP (e.g. state 205(b) reports, environmental reviews, river operations, tailwater monitoring across the watershed, permitting and relicensing of power facilities) • One of the most comprehensive aquatic biological data sets in the nation.	Annual Report

Strategic Partnership Planning	This project is listed in TVA's NRP and focuses on building partnerships with state and other federal agencies, and regional organizations, to address stewardship issues of mutual importance and drive measurable improvement of health of the region's waters.	• A clear understanding of Valley wide water resource concerns and mutual agreement on paths forward with partners (e.g., strategy or priorities, funding, resource requirements, etc.) • Effective best management practices for protecting and improving water reroutes • Improved working relationships with state and national partners • Reestablished focus on partnerships at a regional level.	Annual Report
Tennessee Valley Clean Marina Program	This project is listed in TVA's NRP and promotes environmentally responsible marina and boating practices and will directly link to recreation and to TVA's permitting authority under Section 26(a) of the TVA Act. The Clean Marina Program is designed to reduce water pollution and erosion in the Tennessee River watershed. All new marinas will be required to be certified as part of this program, which encourages boater education, improves coordination among state agencies, and helps communicate marina best-management practices. Also, the program offers incentives for environmentally innovative and proactive marina operations, and it supports the National Clean Boating Campaign.	• Increased awareness with existing marina owners and customers about environmentally protective requirements and best boating practices • Improved water resources conditions in TVA-managed reservoirs as a result of the implementation of best management practices • Enhanced public perception of TVA stewardship efforts • Strengthened compliance with federal and state regulations (e.g. waste water management, fuel management, solid waste management, etc.	Annual Report
Water Resource Outreach Campaign	This project is listed in TVA's NRP which focuses on increasing public awareness and involvement through the promotion of water resource protection and improvement best practices.[v]	• Increased public awareness of the importance and value of protecting water resources within the Tennessee River basin • Enhanced sense of public ownership in the day-to-day management of the basin's water resources. • Enhanced perception of TVA as a leader in water resource stewardship	Annual Report

Reservoir Shoreline Stabilization/ Riparian Management Program	This project is listed in TVA's NRP and helps control critical shoreline erosion. Its goals include protecting significant cultural and other sensitive resources, maintain or improving water quality, and enhancing aquatic and wildlife habitat. Treatment of these sites will include innovative techniques for stabilization (e.g. soil bioengineering) as well as the improvement of traditional methods (e.g., use of geotextiles in the application of rock riprap).	• Stabilization of critically eroding TVA reservoir shoreline and public land • Protection and improvement of water resources; preservation of public land from erosion; recreational opportunism; preservation of significant cultural and biological resources, wildlife habitat, and scenic beauty.	Annual Report
Nutrient Source-Watershed Identification and Improvement Program	The nutrient source-watershed identification and improvement program will establish goals or targets to reduce nutrients (e.g., phosphorous), sediment, or both in TVA-managed reservoirs. It will use existing and monitored nutrient and flow data to assess the nutrient status of TVA reservoirs, helping to target the top three reservoirs having the greatest potential for nutrient source load reductions. This program will provide information to not only better understand and communicate resource conditions within the Tennessee Valley, but also reduce nonpoint nutrient loading from these source-watersheds and also from point sources where appropriate. Such reductions will be proactive in the view of forthcoming regulatory numeric nutrient water quality criteria and nutrient loading allocations that are being developed at the national and state levels. By improving water quality, potential increases in wastewater treatment costs related to emerging reduction requirements may be mitigated, providing a key economic benefit to the region.	• Identification of the major phosphorus and sediment loading sources from watersheds into TVA reservoirs, helping to develop focused nutrient load reduction initiatives • Reduced phosphorous loads into some streams that are currently included in states' lists of nutrient impaired waters (required by Section 303(d) of the Clean Water Act) • Replicable methods and techniques for achieving measurable phosphorus and sediment load reductions and improvements in water quality. • Lower potable water treatment costs • Proactive nutrient reductions to meeting expected future regulatory requirements (increase public perception). Se northern Gulf of Mexico/Mississippi River basin nutrient load reductions program for additional information.	Annual Report
	This NRP project is a demonstration program that	• A better understanding of how nitrogen reacts within a reservoir and	Annual Report

Northern Gulf of Mexico/ Mississippi River Basin Nutrient Load Reductions Program	conducts modeling to determine what nitrogen source-load reduction opportunities exist in a selected lower Tennessee River reservoir (Guntersville to Kentucky reservoirs). The expectation is that a key benefit of such a modeling effort will be reduced nitrogen yields delivered to the northern Gulf of Mexico hypoxic zone. The U.S. Geological Survey Sparrow model has indicated that approximately 90 percent of the nitrogen transported in the lower Tennessee River is delivered to the northern Gulf of Mexico. Within the NRP, this program links to the TVA nutrient source-watershed identification and improvement program. This program also links with the national effort to recover the northern Gulf of Mexico hypoxic zone.	how its yields are exported into downstream water bodies • A continued demonstration effort between local, regional and national stakeholders to show how to potentially reduce nitrogen load amounts to a damaged water resource (Gulf of Mexico hypoxic zone) of national significance • Identification of best management practices for how best to reduce nitrogen loading into and nitrogen yields delivered out of a lower Tennessee River reservoir • Proactive management of potential future regulatory loading allocations from the Tennessee River into the Mississippi River basin and Gulf of Mexico • Increased (positive) public perception associated with TVA's proactive stewardship efforts to address downstream impacts of nutrients.	
External Coordination Efforts	This activity focuses on the identification of an internal process to coordinate its adaptation planning with related efforts among state, local, tribal, and territorial partners. These efforts include TVA participation in the Appalachian Land Conservation Cooperative (LCC) and the Southeast Climate Science Center (CSC).	Improved external coordination	
Dry Ash Handling and Storage	TVA has developed plans to eliminate all wet ash and gypsum storage in the system and convert its 11 operating coal-fired power plants to dry storage. The movement away from wet fly ash systems will help to reduce the overall use of water in TVA's power generation facilities and help to meet sustainability goals as required by Executive Order 13514. The conversion plan has been developed and capital costs have been estimated.	• CUF, COF, JSF and SHF had installed dry fly ash systems prior to this initiative. • The BRF flyash system upgrade has been completed as well as the KIF dry fly ash and gypsum dewatering systems. • The BRF bottom ash and gypsum dewatering systems are underway and scheduled for start-up in late 2014. • The GAF and KIF bottom ash systems are scheduled for 2016-2017. • The PAF Unit 3 dry fly ash conversion is scheduled for 2019.	Annual Performance Reporting

Greenhouse Gas Reduction	TVA's Environmental Policy states the environmental objective that TVA "will stop the growth of emissions and reduce the rate of carbon emissions by 2020 by supporting a full slate of reliable, affordable, lower CO_2 energy-supply opportunities and energy efficiency." In accordance with EO 13514, TVA has set additional GHG reduction targets for Scope 1,2 and 3 activities and annually reports its progress as part of its Strategic Sustainability Performance Plan (SSPP).	• TVA provides an attractive combination of price (¢/kWh) and carbon content (lbs/MWh). • TVA has made asset decisions that have reduced CO_2 emissions 30% below 2005 levels and is projected to reduce CO_2 emissions 40% below 2005 levels by 2020. • The Agency currently delivers electric power containing around 1050 lbs/MWh and is on track to improve that to around 700 lbs/MWh by 2020.	Annual Performance Reporting

TVA's Senior Sustainability Officer is responsible for its annual Climate Change Adaptation Action Plan.

TVA's Senior Sustainability Officer is:

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Vice President, Environment

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Chattanooga, TN 37402

B. CLIMATE CHANGE RISKS AND OPPORTUNITIES

1. TVA's Mission and Vision

Since its inception, the people of the Tennessee Valley Authority (TVA) have maintained a proud history of environmental leadership. On May 18, 1933 President Roosevelt signed the TVA Act into law to create an Agency that serves the Valley through its energy, environment, and economic development mission. Today, the results of TVA's efforts are apparent in the abundant natural resources in the region and the opportunities they afford.

TVA, a corporation owned by the U.S. government, provides electricity for 9 million people at prices below the national average. TVA also provides flood control, navigation and land management for the Tennessee River system, and assists utilities and state and local governments with economic development. TVA receives no taxpayer money and makes no profits.

TVA operates the nation's largest public power system. It provides power through 155 Local Power Company (LPC) distributors of TVA power and 57 directly-served customers, in an area encompassing 80,000-square-miles, including most of Tennessee and parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina and Virginia. Specifically, TVA's Mission is to:

- Provide low-cost power
- Improve navigation and provide for flood control
- Provide for reforestation and the proper use of marginal lands
- Provide for agricultural and industrial development
- Provide for the national defense
- Stimulate technological innovation
- Foster environmental stewardship

While TVA's mission has not changed, the environment in which TVA does business continues to evolve. TVA continually evaluates and adjusts its operations to ensure its achieves its mission—today, and tomorrow.

TVA's Environmental Policy is to provide cleaner, reliable, and affordable energy to support sustainable economic growth in the Tennessee Valley, and to engage in proactive environmental stewardship in a balanced and ecologically sound manner. TVA's pursuits in these areas benefit the well-being of its employees and customers, the people being served, and the natural resources it stewards.

TVA's vision is to be "one of the Nation's leading providers of low-cost and cleaner energy by 2020." This vision helps TVA lead the Tennessee Valley region and the nation toward a cleaner and more secure energy future while meeting the needs of its customers and promoting a strong foundation for a sustainable future.

Initially, all TVA operations were funded by federal appropriations. Direct appropriations for the TVA power program ended in 1959, and appropriations for TVA's land and water, stewardship, management of the Tennessee River and watershed, economic development, and multipurpose activities ended in 1999. Since 1999, TVA has funded all of its operations almost entirely from the sale of electricity and power system financings.

The TVA Board also established a Regional Resource Stewardship Council (RRSC) under the Federal Advisory Council Act to advise TVA on its stewardship activities. In 2013, TVA also created a new Regional Energy Resource Council (RERC) under the Federal Advisory Council Act to advise TVA on its energy resources decision making processes.

TVA is not subject to federal income taxation. Additionally, neither TVA nor its property, franchises, or income is subject to taxation by states or their subdivisions. Section 13 of the TVA Act does, however, require TVA to make tax equivalent payments to states and counties in which TVA conducts power operations or in which TVA has acquired power-producing properties previously subject to state and local taxation. The total amount of these payments is five percent of gross revenues from the sale of power during the preceding year excluding sales or deliveries to other federal agencies and off-system sales with other utilities, with a provision for minimum payments under certain circumstances. Except for certain direct payments TVA is required to make to counties, distribution of tax equivalent payments within a state is determined by individual state legislation.[vi]

TVA's power system financings consist primarily of the sale of debt securities and secondarily of alternative financings such as lease financings. As a wholly-owned government corporation, TVA is not authorized to issue equity securities. TVA also returns funds to the U.S. Treasury. While exempt from local and state taxes, TVA makes tax equivalent payments to states and localities comparable to taxes paid by private companies. TVA's governance structure, updated by Congress in 2005, shares some similarities with that of a private corporation. Policy direction and oversight are provided by a nine-member, part-time board of directors, and ongoing operations are managed by a full-time chief executive officer. Members of the TVA Board are appointed by the President of the United States and confirmed by the United States Senate.

More detailed information about TVA's programs can be found in the annual reports (10-Ks), quarterly reports (10-Qs) and current reports (8-Ks) TVA files with the Security Exchange Commission. View TVA Securities and Exchange Commission filings.

2. A Description of TVA's Programs

a. Low Cost, Reliable Power

TVA is primarily a wholesaler of electricity. TVA sells power to Local Power Companies (LPCs) which then resell power to their customers at retail rates. TVA also sells power to directly served customers, consisting primarily of federal agencies and customers with large or unusual loads. In addition, power that exceeds the needs of the TVA system may, where consistent with the provisions of the TVA Act, be sold under exchange power arrangements with other electric systems.

Power generating facilities operated by TVA on September 30, 2013, included 29 conventional hydroelectric sites, one pumped–storage hydroelectric site, 10 coal-fired sites, three nuclear sites, 14 natural gas and/or oil-fired sites, one diesel generator site, 16 solar energy sites, digester gas co-firing capacity at one coal-fired site, biomass co-firing potential (located at coal-fired sites), and one wind energy site, although a certain number of these facilities were out of service as of September 30, 2013.[vii] Since April 2000, TVA has added energy from three renewable sources--sun, wind, and methane gas--to its power mix. In addition, eight Army Corps of Engineers dams and four Alcoa dams contribute to the TVA power system.[viii]

TVA acquires power from a variety of power producers through long-term and short-term power purchase agreements; as well as, through power spot market purchase. During 2013, TVA acquired approximately 10 percent of the power that it purchased on the power spot market, approximately one percent through short-term power purchase agreements, and approximately 89 percent through long-term power purchase agreements.[ix]

The TVA transmission system is one of the largest in North America. TVA's transmission system has 68 interconnections with 12 neighboring electric systems, and delivered nearly 165 billion kWh of electricity to TVA customers in 2013. In carrying out its responsibility for grid reliability in the TVA service area, TVA has operated with 99.999 percent reliability over the last 14 years in delivering electricity to customers. [x]

TVA, in partnership with its LPCs and directly served customers, is developing a broad portfolio of energy efficiency, demand response, and renewable energy programs designed to help reduce long-term energy supply costs in the TVA service area.[xi]

b. Environmental Stewardship

TVA's mission includes managing the Tennessee River, its tributaries, and public lands along the shoreline to provide, among other things, year-round navigation, flood damage reduction, affordable and reliable electricity, and consistent with these primary purposes, recreational opportunities, adequate water supply, improved water quality, and natural resource protection.[xii]

There are 49 dams that comprise TVA's integrated reservoir system. The reservoir system provides approximately 800 miles of commercially navigable waterways and also provides significant flood reduction benefits both within the Tennessee River system and downstream on the lower Ohio and Mississippi Rivers. The reservoir system also provides a water supply for residential and industrial customers; as well as, cooling water for some of TVA's coal-fired and nuclear power plants.

TVA's Environmental Policy provides objectives for an integrated approach related to providing cleaner, reliable, and affordable energy, supporting sustainable economic growth and engaging in proactive environmental stewardship. The Environmental Policy and Natural Resource Plan provides additional direction in several environmental stewardship areas, including water resource protection and improvements, sustainable land use, and natural resource management. TVA also manages approximately 11,000 miles of shoreline, 650,000 surface acres of reservoir water, and 293,000 acres of reservoir lands for cultural and natural resource protection, recreation, and other purposes.

c. Economic Development

Since its creation in 1933, TVA has promoted the development of the Tennessee Valley. Economic development, along with energy production and environmental stewardship, is one of the integrated purposes of TVA. TVA works with its LPCs, regional, state, and local agencies, and communities to showcase the advantages available to businesses locating or expanding in TVA's service area. TVA's primary economic development goals are to recruit major industrial operations to locate in the Tennessee Valley, encourage the location and expansion of companies that provide quality jobs, prepare communities in the Tennessee Valley for economic growth, and offer support to help grow and sustain small businesses. TVA seeks to meet these goals through a combination of initiatives and partnerships designed to provide financial assistance, technical services, industry expertise, and site-selection assistance to new and existing businesses. TVA's economic development efforts helped recruit or expand over 170 companies into the TVA service area during 2013. These companies announced capital investments of approximately $5 billion and the expected creation and/or retention of over 52,000 jobs. [xiii]

d. River Management and Flood Control Activities

TVA manages the Tennessee River, its tributaries, and public lands along the shoreline to provide, among other things, year-round navigation, flood damage reduction, affordable and

reliable electricity and, consistent with these primary purposes, recreational opportunities, adequate water supply, improved water quality, and natural resource protection.

TVA's integrated reservoir system provides 800 miles of commercially navigable waterways and significant flood reduction benefits both within the Tennessee River system and downstream on the lower Ohio and Mississippi Rivers. The reservoir system also provides a water supply for residential and industrial customers; as well as, cooling water for some of TVA's coal-fired and nuclear power plants.

The Tennessee River watershed has one of the highest annual rainfall totals of any watershed in the United States, averaging 51 inches per year. From October 1, 2012, through September 30, 2013, 62 inches of rain fell in the Tennessee Valley. TVA manages the Tennessee River system in an integrated manner, balancing hydroelectric generation with navigation, flood damage reduction, water quality and supply, and recreation. TVA spills or releases excess water through the tributary and main stem dams in order to reduce flood damage to the Tennessee Valley. TVA typically spills only when all available hydroelectric generating turbines are operating at full capacity and additional water still needs to be moved downstream.

During 2013, TVA estimated its reservoir operations averted approximately $750 million in flood damages.[xiv]

e. Technological Innovation

TVA makes investments in science and technological innovation to assist in meeting future challenges in key areas. These are identified as "Signature Technologies" wherein TVA is seeking to establish national leadership in research, development, and demonstration. TVA is currently focused on three Signature Technologies: small modular reactors (SMRs), grid modernization ("smart grid") for transmission and distribution systems, and energy utilization technologies, with a particular emphasis on energy efficiency, load management, and electric transportation.

TVA has chosen SMRs as one of three signature technologies that support TVA's technology innovation mission, and could provide an important option for clean, base-load energy for TVA's customers. TVA is a member of the B&W Power America team, which the DOE selected in November 2012 for a grant award for the design and licensing of B&W mPower SMRs. Specifically, under a contract that TVA executed with B&W in February 2013, TVA, B&W, and Generation mPower, LLC (a B&W affiliate, minority owned by Bechtel), are preparing a license application to the NRC to license up to four B&W mPower™ SMRs at TVA's Clinch River Site in Roane County, TN. In April 2013, B&W and the DOE executed a cooperative agreement implementing the DOE award, under which TVA (through B&W) is reimbursed by the DOE for roughly half of its qualified site study and license development costs, retroactive to October

2012. Currently, TVA is performing site characterization work, including gathering meteorological data, surveying species and cultural and archeological resources, and studying site hydrology. As reported in the 2013 10-K, TVA has completed approximately 50 percent of the subsurface studies at the Clinch River site that are necessary to support the environmental review and NRC license application. TVA will not decide whether to submit the license application to the NRC until mid-2015, and will not make subsequent construction decisions regarding SMRs at the Clinch River site for several years thereafter.

TVA's grid modernization research goals are to advance the implementation of technology options identified from evolving grid modernization roadmaps which support TVA's transmission system and the LPCs' distribution systems. The focus is on developing and demonstrating technology options that help sustain reliability, lower costs, and mitigate risks for TVA and LPCs. Among the more significant efforts in this area are demonstrations of new power system sensing and control technologies that are designed to increase operator situational awareness, provide better control of power flows, and optimize asset management.

In the area of energy utilization, TVA's near-term concentration is on the development and maintenance of a pipeline of emerging energy efficiency and load management technologies for market and program readiness. TVA's efforts are directed towards demonstrating and validating the performance and reliability of new efficiency technology as well as the value of energy efficiency and load management technologies for both the consumer and the utility. Additionally, TVA is conducting demonstrations to support the development of an electric transportation and infrastructure business plan.

TVA leverages research and development activities through partnerships with distributors of TVA power, the Electric Power Research Institute (EPRI), the Department of Energy (DOE), Oak Ridge National Laboratory, the National Atmospheric Deposition Program[xv], the National Park Service[xvi], other utilities, universities, and industry vendors. Some of these activities include: developing technologies to make electric vehicles and the charging stations that fuel them work together efficiently, finding ways to minimize demands on the power grid, improving the energy efficiency of the power system, and developing a better understanding of air quality in the Great Smoky Mountains National Park.

3. *Planning for Climate Change Related Risk:* TVA's Adaptation Risk and Opportunities

By definition, all planning activities are always conducted under conditions of uncertainty. Adaptation planning is no different. Interagency efforts have been, and continue to be, underway to better understand the uncertainty associated with climate change. In the United States, the Global Change Research Act of 1990 mandates an assessment of the impacts of

global change in the U.S. be conducted by the U.S. Global Change Research Program (USGCRP) every four years. EO 13653, *Preparing the United States for the Impacts of Climate Change*, contains a new requirement for all Federal agencies to update their Adaptation Plans within one year after the publication of each quadrennial National Climate Assessment (NCA) report.[xvii]

a. High-Level Adaptation Risk and Opportunities Analysis

In response to *Preparing Federal Agency Climate Change Adaptation Plans In Accordance with Executive Order 13514--February 29, 2012*, and EO 13653--November 6, 2013 *Preparing the United States for the Impacts of Climate Change*, **Table 2** summarizes the key high-level adaptation risks and opportunities to TVA's mission, programs, and operations in the short- and long-term. The risks and opportunities analyzed are within the ranges considered by TVA's current planning and evaluation processes as discussed in **Section C**.

Table 2: Key High-Level Adaptation Risk and Opportunity Summary

Key Issue	Description	Potential Short Term and Long Term Direct and Indirect Effects
Electricity Demand[xviii]	Electricity demand may increase (especially in the South and Southwest, which generally have higher per capita electricity use.)[xix]	The 2014 NCA reported that in the Southeast, the number of observed extreme hot days has tended to decrease or remain the same while the number of very warm summer nights has tended to increase. The number of extreme cold days has also tended to decrease. [xx] Over time, however, the 2014 NCA projects demands for electricity for cooling will increase and demands for heating will decrease in every U.S. region as a result of increases in average temperatures and high temperature extremes. [xxi] USGS NEX-DCP30 data is generally projecting about a 3° F Annual average Max Temperature increase, 2025-2050 for Tennessee[xxii] The 2009 NCA concluded the demand for cooling energy generally increases from 5% to 20% per 1.8° F of warming and demand for heating energy generally drops by 3% to 15% per 1.8° F of warming.[xxiii] Specific impacts are difficult to predict as many factors besides climate change affect energy demand (including population changes, economic conditions, energy prices, consumer behavior, conservation programs, and changes in energy-using equipment). USGCRP and DOE assessments also indicate that higher air and water temperatures may diminish the efficiency by which power plants convert fuel to electricity.[xxiv]
Reservoir Operations and Hydropower Generation	Climate change, coupled with human adaptation, will influence both the demand for and supply of water. [xxv]	These changes may affect hydropower generation, thermoelectric cooling, reservoir-based recreation, navigation, municipal and industrial uses, and environmental flows. Every adaptation and mitigation option involves tradeoffs in how it increases or decreases stress on energy systems and water and land resources. The 2014 NCA concludes that while some facilities may face water-related limitations, these could be offset to some degree by the use of innovative technologies.[xxvi]

	Many U.S. Army Corps of Engineers "rule curves" that require a certain amount of space to be saved in a reservoir at certain times of the year to capture a potential flood have never been modified.[xxvii]	A TVA Reservoir Operations Policy (ROS) was developed during the Reservoir Operations Study and Environmental Impact Statement (EIS-2004). The reservoir operations include flood guides that are based upon TVA's hydrologic record and many years of operating experience. Several flood guides were changed as a result of the ROS, and will continue to be reassessed over time.
	Evaporative losses from industrial and thermoelectric cooling may increase.	The 2014 NCA concluded change in projected precipitation for the Southeast has high uncertainty, but that there is still a reasonable expectation of reduced water availability due to the increased evaporative losses resulting from rising temperatures alone.[xxviii]
	Precipitation could significantly increase.	The 2014 NCA concluded the frequency of extreme precipitation events has been increasing across the Southeast region, particularly over the past two decades.[xxix] The *1988 TVA Sensitivity Study* concluded that major dams operating at or above normal maximum levels for extended periods of time may necessitate a reevaluation of dam safety at these projects.[xxx]
	Precipitation could significantly decrease.	Conversely, drought is a normal component of the Southeast's climate system.[xxxi] The 2014 NCA also concluded projections of future precipitation patterns are less certain than projections for temperature increases. Because the Southeast is located in the transition zone between projected wetter conditions to the north and drier conditions to the southwest, many model projections show only small changes relative to natural variations. However, many models do project drier conditions in the far southwest of the Southeast region and wetter conditions in the far northeast of the region, consistent with the larger continental-scale patterns.[xxxii] The *1988 TVA Sensitivity Study* also concluded the reduced runoff conditions may decrease the likelihood of operations at or above maximum pool levels.[xxxiii]
Effects of Changing Runoff and Water Temperatures	Climate change is expected to affect hydropower and thermoelectric power plants directly through changes in runoff (average, extremes, and seasonality) and indirectly through increased competition with other water uses. Higher water temperatures affect the efficiency of electric generation and cooling processes. It also limits the ability of utilities to discharge heated water to streams due to regulatory requirements and anticipated impacts to ecosystems and	EPRI research indicates that approximately 25% of existing electric generation in the U.S. is located in counties projected to be at high or moderate water supply sustainability risk in 2030.[xxxv] The 2014 NCA concludes 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.[xxxvi] The 2014 NCA also indicates a national average increase in annual precipitation, owing to significant increases across the central and northeastern portions of the nation and a mix of increases and decreases elsewhere.[xxxvii] Changes in projected precipitation are small in most areas of the U.S, but vary both seasonally and regionally. The number of heavy downpours has generally increased and is projected to increase for all regions. Warmer air temperatures will result in warmer water. [xxxviii]

	biodiversity.[xxxiv]	The 2009 EPRI report concluded that multi-model means of climate results suggests that effects on most existing human uses of water (for example, for cooling water or hydropower) are also likely to be modest and occur within the range of existing adaptive capacity, although some adjustments in water planning will likely be necessary.[xxxix]
Extreme Weather	Severe weather, such as ice storms, thunderstorms, tornados and hurricanes can have a negative impact on energy infrastructure.[xl]	The 2014 NCA 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.[xli] The frequency of extreme-precipitation-events has increased across the Southeast, particularly over the last two decades.[xlii] The increase is pronounced across the lower Mississippi River Valley and along the northern Gulf Coast.[xliii] Although the number of major tornadoes has increased over the last 50 years in the Southeast, there is no statistically significant trend.[xliv]
Heat	The leading cause of weather-related deaths in the United States is heat. With the exception of the 1970s to the 1990s, when the use of air conditioning rapidly increased, the number of deaths due to heat is positively correlated with increasing temperature and humanity.[xlv]	The 2014 NCA reported Southeast as one of the few regions globally not to exhibit an overall warming trend in surface temperature over the 20th century.[xlvi] This "warming hole" also includes part of the Great Plains and Midwest regions in the summer.[xlvii] Temperatures increased rapidly in the early part of the 20th century, then decreased rapidly during the middle of the 20th century. Since the 1960s, temperatures have increased. Recent increases are most pronounced during summer, particularly along the Gulf and Atlantic coasts. Temperature trends over the period of 1895-2011 are found to not be statistically significant for any season.[xlviii] The 2014 NCA also concludes, although temperatures are expected to fluctuate over time due to natural climate variability, the Southeast is generally expected to experience a temperature increase during this century. Some major impacts of this projected warming trend include increases in the number of days exceeding 95^{o}F.[xlix] The GAO also observed, apart from risks related to extreme weather events, increasing temperatures may decrease transmission system efficiency and could reduce available transmission capacity, as well as the overall efficiency of the grid.[l]
Floods	Heavier precipitation can increase flood risk, expand flood hazard areas, increase the variability of stream flows (i.e., higher high flows and lower low flows) and increase the velocity of water during high flow periods, thereby increasing erosion. Precipitation changes can often be managed by the use of reservoirs, and can	The 2014 NCA reports, despite a long-term increase in extreme precipitation events, there is no discernible trend in the magnitude of floods along non-urbanized, unregulated streams across the Southeast region.[li] The increase in extreme precipitation, coupled with increased runoff due to the expansion of impervious surfaces and urbanization, has led to an increased risk of flooding in urban areas of the region (e.g., the record-breaking Atlanta, GA flood in 2009).[lii]

	increase hydropower power production. Floods can also have adverse effects on water quality and aquatic ecosystem health.	
Water Quality	Downpours can trigger sewage overflows and contaminated drinking water.[liii]	Warmer air temperatures will result in warmer water. Warmer water holds less dissolved oxygen making instances of low oxygen levels or "hypoxia" more likely; foster harmful algal blooms; and alter the toxicity of some pollutants. [liv] This will be more pronounced on mainstem reservoirs, where brief periods of low DO can already be observed during summer under drought conditions. The 2014 NCA 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 2014 NCA concludes areas of the U.S. that are projected to see increases in precipitation, and increases in intense rainfalls, may experience water quality challenges.[lv]
Temporal and Geographic Rainfall Variation	Change in extreme events, droughts, and daily and weekly flooding pose threats to the region's infrastructure even when monthly and annual water supply does not change dramatically.[lvi] Climate impacts in this category are related to changes in rainfall, but also to changes in temperature, which affects evaporation and evapotranspiration (the sum of evaporation and plant transpiration from the Earth's land surface to the atmosphere). While water is currently abundant, climate stressors could change that abundance, either locally or region wide, leading to impacts and the need for adaptive measures.[lvii]	The *EPRI Report* concluded while changes in runoff in the TVA region are likely to be modest, some impacts could result from highly localized changes in the temporal distribution of precipitation that may have major impacts on both water supply and power supply along with recreation in specific parts of the TVA region--even if the region as a whole does not experience a major impact.[lviii]
Prolonged Droughts	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.[lix]	Water resources in the Southeast are abundant and support heavily populated urban areas, rural communities, unique ecosystems, and economies based on agriculture, energy, and tourism. The region also experiences extensive droughts, such as the 2007 drought in Atlanta, Georgia that created water conflicts among three states.[lx] While the 2014 NCA concludes change in projected precipitation for the Southeast has high uncertainty, it also concludes there is still a reasonable expectation that there will be reduced

		water availability due to the increased evaporative losses resulting from rising temperatures alone.[lxi]
Decreased Dissolved Oxygen Levels	Warmer air temperatures will result in warmer water. Warmer water holds less dissolved oxygen making instances of low oxygen levels or "hypoxia" more likely; foster harmful algal blooms; and alter the toxicity of some pollutants. [lxii]	The 2014 NCA observes 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, areas of the U.S. that are projected to see increases in precipitation, and increases in intense rainfalls, like the Northeast, Midwest, and mountainous West may see decreases in dissolved oxygen.[lxiii] Prolonged, heavy releases at Kentucky Dam can lead to supersaturation of DO impacting aquatic life in the tailwater.
Biodiversity Impacts	The 2014 NCA concludes climate change impacts on biodiversity are already being observed in alteration of the timing of critical biological events such as spring bud burst and substantial range shifts of many species. In the longer term, there is an increased risk of species extinction. These changes have social, cultural, and economic effects. Events such as droughts, floods, wildfires, and pest outbreaks are already disrupting ecosystems. These changes limit the capacity of ecosystems, such as forests, barrier beaches, and wetlands, to continue to play important roles in reducing the impacts of these extreme events on infrastructure, human communities, and other valued resources.[lxiv]	The Tennessee Valley region supports a wide diversity of terrestrial and aquatic ecological habitats. This habitat diversity results in the area being one of the most species-diverse in North America and a center for unusually high levels of endemism (i.e. species confined to a particular geographic region). Potential climate impacts are related to changes in ecosystem type and acreage and measures of species diversity and can be attributed to changes in temperature, precipitation and atmospheric CO_2 concentrations.[lxv] At this time, it is uncertain where the greatest climate change-induced impacts to aquatic organisms and their ecosystems may occur. Predictions are further confounded by the probability that temperature change will likely not occur evenly across the Valley, as a result, it is difficult to predict how warm- and cold-water taxa will respond to changing water temperatures since other environmental factors; such as, land-use changes, also strongly influence species population densities and geographic distributions.[lxvi] Highly specialized Species restricted to higher elevations are expected to be impacted initially.
In-stream Habitats	Changes to in-stream flow levels may have substantial impacts on the habitats and biodiversity supported by rivers and other water bodies.	The *EPRI Report*, Potential Impact of Climate Change on Natural Resources in the Tennessee Valley Authority Region, concluded that changes to in-stream flow levels may have substantial impacts on the habitats and biodiversity supported by rivers and other water bodies in the TVA region. IPCC reports that low water levels can cause reproductive problems among fish and amphibian species and that river-spawning fish may also be directly impacted by changes in flow levels.[lxvii] The EPRI report concluded that, within the TVA region, the overall effects of climate change on in-stream flow will vary depending on run-off cycles, precipitation levels, and river characteristics. In-stream flow rates will also be indirectly affected by water management decisions between competing water uses.[lxviii]
Habitat Migration	Climate change may have an impact on animal and plant species. The 2009 USGCRP	The 2014 NCA concluded the lengthening of the frost-free season has been somewhat greater in the western U.S. than the eastern U.S.,[lxx] increasing by 2 to 3 weeks in the

	concluded that in the United States spring now arrives on an average of 10 days to two weeks earlier than it did 20 years ago.[lxix]	Northwest and Southwest, 1 to 2 weeks in the Midwest, Great Plains, and Northeast, and slightly less than 1 week in the Southeast. These differences mirror the overall trend of more warming in the north and west and less warming in the Southeast.[lxxi]
Air Quality	Changes in meteorological conditions could affect future ozone and $PM_{2.5}$ concentrations. Climate change can also affect air quality by increasing emissions from natural sources and wildfires.	The 2014 NCA reported that several studies project that climate change could increase troposphere ozone levels over broad areas of the country, especially on the highest-ozone days.[lxxii] Climate change also has the potential to lengthen the ozone seasons (the months of the year when weather conditions, along with pollutants in the air, can result in the formation of elevated levels of ground-level ozone in particular locations around the country), and may increase individuals' vulnerability to air pollution.[lxxiii] The *EPRI Report* states the TVA service territory has few metropolitan areas that currently do not meet the National Ambient Air Quality Standards (NAAQS) for ozone, small particulate matter ($PM_{2.5}$), or both. Currently, "Knoxville-Sevierville-LaFollette" is in nonattainment for the 2006 $PM_{2.5}$ 24-hour standard.[lxxiv] Air trends have shown dramatic improvement in ozone and $PM_{2.5}$.
Natural Resource-Based Recreation	Natural resource-based recreation in the TVA service territory could be affected directly by temperature and precipitation changes, as well as indirectly through effects on water resources, forests, and unmanaged ecosystems.[lxxv]	Recreation is sensitive to weather and climate. Climate change impacts to recreation can be difficult to project. As the climate warms, changes in precipitation and runoff are expected to result in both beneficial (in some regions) and adverse impacts.[lxxvi] Warm and wet climate adaptation scenarios generally produce positive recreational impacts; whereas warm and dry scenarios generally produce negative recreational impacts. The *EPRI Report* concluded natural resource-based recreation in the TVA service territory could be affected directly by climate changes; such as, temperature and precipitation changes, as well as indirectly through effects on water resources, forests, and unmanaged ecosystems.[lxxvii]

b. External Partnership and Stakeholder Coordination

Partnerships are a critical component of TVA's future implementation, education and operations success. TVA, along with other agencies, is tasked with finding new and creative ways to deal with funding and personnel challenges to effectively manage nonrenewable resources.

EO 13653 encourages interagency collaboration to share the latest data and best practices on climate preparedness both across agencies as well as to support State, local, tribal, and private sector efforts to build climate preparedness.

TVA continues to develop its overarching public engagement programs to increase public awareness and promote opportunities for volunteer involvement, environmental education,

financial/resource assistance and collaborative partnerships.[lxxviii] The TVA Board also established a Regional Resource Stewardship Council (RRSC) under the Federal Advisory Council Act to advise TVA on its stewardship activities. In 2013, TVA also created a new Regional Energy Resource Council (RERC) under the Federal Advisory Council Act to advise TVA on its energy resources decision making processes. External stakeholder coordination processes are utilized in the TVA Integrated Resource Plan and the Natural Resource Plan processes.

c. Existing Cross-Cutting Planning Efforts

Strategic Sustainability Performance Plan (SSPP)

TVA's Senior Sustainability Officer (SSO) is also responsible for its Climate Change Adaptation Action Plan. TVA's Strategic Sustainability Performance Plan (SSPP) goals and current performance can be found on its current OMB Scorecard on Sustainability/Energy.

Environmental Justice Strategy

TVA will consider environmental justice impacts in a manner appropriate for the process utilized.

Applicable National Plans and Reports

To the extent practicable, this Climate Change Adaptation Action Plan has attempted to align with existing cross-cutting planning efforts, including the:

- ***National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*,** Interagency Climate Change Adaptation Task Force, October 2011. *See* http://www.cakex.org/sites/default/files/2011_national_action_plan.pdf
- ***National Fish, Wildlife and Plants Climate Adaptation Strategy***, U.S. Fish and Wildlife Service, NOAA, AFWA, 2012. *See* http://www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Final.pdf
- ***National Ocean Policy Implementation Plan***, National Ocean Council, April, 2013,. *See* http://www.whitehouse.gov/sites/default/files/national_ocean_policy_implementation_plan.pdf
- **National Water Program 2012 Strategy: Response to Climate Change,** Environmental Protection Agency, December 2012. *See* http://water.epa.gov/scitech/climatechange/upload/epa_2012_climate_water_strategy_full_report_final.pdf
- **Climate Change: Energy Infrastructure Risks and Adaptation Efforts, United States Government Accountability Office, Report to Congressional Requesters**, GAO-14-74, January 2014. *See* http://www.gao.gov/assets/670/660558.pdf
- **Federal Interagency Working Group on Environmental Justice, *Ensuring Consideration of Environmental Justice Issues In the Development of Agency Adaptation Plans Pursuant to EO 13514 and EO 13563*,** May 30, 2014.

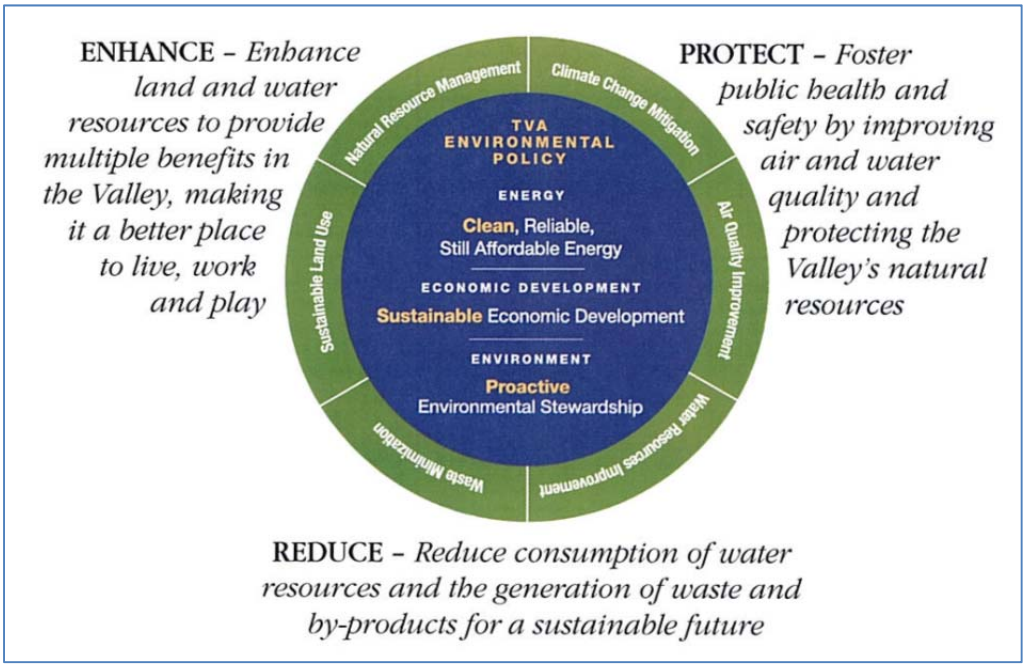
C. TVA's Adaptation Planning and Evaluation Process

1. TVA's Environmental Policy

The focus on "Enhance, Protect and Reduce" aligns TVA's *Environmental Policy* with its *Vision*.

TVA will lead in reducing the environmental impact of its operations (including procurement, acquisition, real property or leasing decisions) and in protecting and enhancing the Valley's natural resources.

Figure 3: Overview of TVA's Environmental Policy



2. Guiding Principles for Climate Change Adaptation[lxxix]

The *Support Document* to the *Implementing Instructions* set out the following *Guiding Principles for Climate Change Adaptation*:

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

3. TVA's Major Environmental Planning Processes

TVA's major environmental planning processes are 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, such as E.O. 13514, *Federal Leadership in Environmental, Energy and Economic Performance.*[lxxx] Environmental goals are an integral part of how TVA does business and are tracked along with its other business objectives.

Each TVA major planning process shall identify any 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 should include:

- 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 and
- whether the action can be addressed exclusively by the agency or if stakeholders will need to be involved.
- the Identification of any relevant milestones and responsible agency components or offices

The GAO, in its January 2014 report, *Climate Change: Energy Infrastructure Risks and Adaptation Efforts*, found that a number of measures exist to help reduce climate-related risks and adapt the nation's energy systems to weather and climate-related impacts. These measures generally fall into two categories—hardening and resiliency. Hardening involves making physical changes that improve the durability and stability of specific pieces of infrastructure—for example, elevating and sealing water-sensitive equipment—making it less susceptible to damage. In contrast, resiliency measures allow energy systems to continue operating after damage and allows them to recovery more quickly; for example, installing back-up generators to restore electricity more quickly after severe weather events.[lxxxi]

According to DOE's 2010 report, *Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons*, choices to harden infrastructure can require significant investment by industry. In contrast, resiliency measures are focused on quickly recovering from damage to various parts of the energy supply chain, thereby enabling the system to continue to operate.

Resiliency can take many forms and can be implemented by industry participants anywhere along the energy supply chain.[lxxxii]

a. TVA's Integrated Resource Plan (IRP)

TVA's current *IRP,* adopted by TVA's Board of Directors in 2011, functions as a roadmap to help guide TVA in meeting the region's electricity needs through 2029. Climate change mitigation was specifically included in a majority of IRP scenarios studied. The IRP recommends a strategic direction that focuses on a diverse mix of energy sources, including alternative energy portfolios, and evaluates a broad range of potential future scenarios. The 2011 IRP is currently in the process of being updated in response to major changes in electrical utility industry trends since 2011. As part of the current study, TVA intends to prepare a programmatic Supplemental Environmental Impact Statement (EIS) to assess the impacts associated with the implementation of the updated IRP. TVA will use the EIS process to elicit and prioritize the values and concerns of stakeholders; identify issues, trends, events, and tradeoffs affecting TVA's policies; formulate, evaluate and compare alternative portfolios of energy resource options; provide opportunities for public review and comment; and ensure that TVA's evaluation of alternative energy resource strategies reflects a full range of stakeholder input. Public comment is invited concerning both the scope of the Supplemental EIS and environmental issues that should be. [lxxxiii]

b. TVA's Natural Resource Plan (NRP)

TVA's *NRP*, was also adopted by TVA's Board of Directors in 2011. The NRP is designed to enhance stewardship of public recreation facilities, water resources, wildlife and plants and historic and cultural sites on TVA-managed lands. Implementation of the NRP is expected to be staged over a 20-year period. It is expected to be reviewed and updated at least every five years. The NRP also guides TVA in achieving the objectives of its *Environmental Policy* for a more systematic and integrated approach to natural resource stewardship.

c. TVA's Reservoir Land Management Plans

TVA develops comprehensive plans for the management of reservoir lands. Plans are developed with participation by public agencies and officials, private organizations and individuals. Many of the land plans are available online.

d. TVA's Shoreline Management Policy

In 1999, after extensive environmental review and public comment, TVA inaugurated its Shoreline Management Policy to improve the protection of shoreline and aquatic resources while continuing to allow reasonable public access to both.

4. TVA's Priority Actions

As part of its September 30, 2011 compliance requirement, TVA identified 3-5 preliminary priority actions to improve its capability to assess and build resilience to climate impacts. Several portions of TVA's natural resource management program align with national climate

change assessment programs, national data collection priorities and fulfill vulnerability assessment requirements**.** TVA intends to continue to focus on these priority actions as part of its NRP implementation.

Goal 1: Water Resources Management:

- Provide sustainable, healthy water resources by collaborating to improve and protect water quality in the Tennessee River Watershed.
- Prioritize programs to provide opportunities to conduct water resource improvement efforts on TVA-managed lands and facilities.
- Ensure a comprehensive approach to assess biological conditions across the Valley.

Goal 2: Reservoir Lands Planning:

- Develop Reservoir Land Management Plans
- Provide a holistic approach to balancing shoreline development, recreational use, sensitive and natural resource management needs, and other uses in a way that maintains regional quality of life and economic growth.
- Land planning is a systematic method of identifying and evaluating the most suitable use of public land under TVA stewardship.

Goal 3: Biological and Cultural Resources Management:

- Protect and conserve natural resources while promoting recreational opportunities throughout the Valley.
- Biological Resources will focus on three distinct areas: habitat management, land conditions assessments and dispersed recreation.
- Cultural Resources will prioritize monitoring and protection of archaeological sites through shoreline stabilization as well as through public education and outreach.

5. Performance Measures

The *National Water Program 2012 Strategy: Response to Climate Change* found the most amenable approach for evaluating progress is to assess institutional progress toward becoming a resilient and adaptive program. TVA is adopting a phased approach that uses indicators of progress and emphasizes peer-to-peer learning rather than using a top-down mandate.[lxxxiv]

As appropriate, TVA will identify criteria for deciding which programs to target and how those criteria are identified and necessary. Each applicable process should consider whether or not climate change will impact their ability to procure critical materials or inputs, and seek to address those challenges, including the risk mitigation strategy chosen, the identification of any relevant milestones and responsible agency components or offices.

D. ACTIONS TO BETTER UNDERSTAND CLIMATE CHANGE RISKS AND OPPORTUNITIES

Monitoring and evaluation serve a very important function in providing the scientific underpinnings of *informed* policy. Responses to the climate change challenge will almost certainly evolve over time. Determining and refining adaptation responses will be an iterative process involving scientists, policymakers, and public and private decision makers at all levels.[lxxxv] **Table 3** summarizes TVA's planned near and mid-term actions to better understand climate change risks and opportunities as reported in its 2012 SSPP. Progress is expected to continue subject to budget approval and constraints.

Table 3: TVA Actions to Better Understand Climate Change Risks and Opportunities

TVA NRP Climate Sentinel Monitoring	**Action Description**	This program is listed in TVA's NRP and focuses on collecting biological, chemical and physical data in each of the five predominant eco-regions in the Tennessee Valley.[lxxxvi]
	Action Goal	The goal of Climate Change Sentinel Monitoring is to collect baseline data to assess and analyze potential biological, ecological, and hydrological responses of aquatic ecosystems related to climate change.
	Agency Lead	Environment
	Risk or Opportunity	Better understanding of potential climate change effects on streams, including water quality and their unique biodiversity within the Tennessee River watershed.
	Scale	Regional
	Timeframe	Planning during FY2012; Monitoring begins in FY2013 in the five predominant ecoregions with ten sites a year. One of the five ecoregions (Mississippi Alluvial Plain) may be problematic for establishing a sentinel monitoring site.
	Implementation Methods	Percent samples completed; Complete and timely annual report.
	Performance	Ongoing
	Inter-Governmental Coordination	Coordination across Federal, state, tribal, or other partners are appropriate and critical to advance this action.
	Resource Implications	We are going to integrate monitoring, modifications and additions with the existing monitoring program. TVA will be dedicating non-appropriated funds, as practicable, at its discretion.
	Challenges/Further Considerations	Continued funding. Finding reference sites that qualify for sentinel monitoring. Balancing partnerships--aligning our efforts with what others are doing while maintaining our commitments as outlined within the NRP.
	Highlights of Accomplishments to Date	Willingness of other agencies and organizations to get involved, including the potential involvement of three Federal agencies and six state agencies.

Aquatic Ecology Management	**Action Description**	This program is listed in TVA's NRP and focuses on the enhancement of aquatic biological communities in TVA streams, reservoirs and tailwaters.
	Action Goal	Identify and protect exceptionally diverse aquatic biological communities.
	Agency Lead	Environment
	Risk or Opportunity	Protection and improvement of water resources in the Tennessee River watershed; one of the most biologically rich watersheds in North America.
	Scale	Regional
	Timeframe	Target priority watersheds, build partnerships, and begin implementation in 2013-2014
	Implementation Methods	Build partnerships; collaborate with partners to develop implementation plans, pool resources with other agencies and partners to implement protection and improvement measures.
	Performance	Ongoing
	Inter-Governmental Coordination	Coordination across Federal, state, tribal, or other partners are appropriate and critical to advance these activities.
	Resource Implications	TVA will be dedicating non-appropriated funds, as practicable, at its discretion.
	Challenges/Further Considerations	Continued funding. Balancing partnerships--aligning our efforts with what others are doing while maintaining our commitments as outlined within the NRP.
	Highlights of Accomplishments to Date	Willingness of other agencies and organizations to get involved, including the potential involvement of multiple Federal, state, and local organizations across the Valley.
Strategic Partnership Planning	**Action Description**	This NRP program focuses on building strong partnerships with state and other federal agencies, and with regional nongovernmental organizations, to address stewardship issues of mutual importance and drive measurable improvement of health of the region's waters.[lxxxvii]
	Action Goal	
	Agency Lead	Property & Natural Resource Management
	Risk or Opportunity	Develop shared understanding of potential climate change effects on the Tennessee River watershed and identify opportunities to improve and/or maintain water quantity and water quality.
	Scale	Regional
	Timeframe	Planning in FY2012, Begin in FY2013 and continuing through FY2020.
	Implementation Methods	Establish partnerships that will collaboratively advance TVA's water resource improvements, and also serve as potential sources of shared funding.
	Performance	Ongoing
	Inter-Governmental	Describe and reaffirm <u>current</u> partnerships and strengthen TVA

	Coordination	participation with those agencies, NGOs (Non-Governmental Organizations), and other Valley and Federal Stakeholders.
	Resource Implications	Utilize existing resources to the extent possible and develop additional resources as new opportunities are identified. TVA will be dedicating non-appropriated funds, as practicable.
	Challenges/Further Considerations	Maintaining alignment with other agencies and ensuring adequate future funding.
	Highlights of Accomplishments to Date	Three projects with the Tennessee Department of Environment and Conservation addressing impaired streams and natural habitats in the Roane County area; support for State of Tennessee's lead Water Quality Improvement Initiative; and assisting the state's Green Infrastructure and Low Impact Development Grant Program. These projects are all supplemental environmental projects selected to offset $2M of the Tennessee Commissioner's Order after the Kingston ash spill.
Water Resource Outreach Campaign	**Action Description**	This NRP program focuses on increasing public awareness and involvement through the promotion of water resource protection and improvement best practices.[lxxxviii]
	Action Goal	
	Agency Lead	Property and Natural Resource Management
	Risk or Opportunity	Develop better understanding of potential climate change effects on the Tennessee River watershed and identify opportunities to increase public awareness of the issue.
	Scale	Regional
	Timeframe	Begin in 2013 and continuing through 2020
	Implementation Methods	Develop a matrix of public outreach topics, materials (existing or to be developed), and target audiences. Update existing and prepare new outreach materials and presentations. Develop and follow an integrated plan for delivering water resource outreach.
	Performance	Ongoing
	Inter-Governmental Coordination	Ensure our efforts are coordinated with others.
	Resource Implications	Adequate funding must be procured and maintained. TVA will be dedicating non-appropriated funds, as practicable.
	Challenges/Further Considerations	Continued funding. Maintaining program focus over a long timeframe.
	Highlights of Accomplishments to Date	Initial inventory of existing materials has been initiated and historical programs are ongoing.

E. Actions to Address Climate change Risks and Opportunities

Table 4 identifies the actions TVA will continue or initiate in FY2013 and beyond to address climate change risks and opportunities to its mission, programs, and operations. Progress is expected to continue subject to budget approval and constraints.

Table 4: TVA Actions to Address Climate Change Risks and Opportunities

Internal Climate Change Adaptation Oversight Process	**Action Description**	This action focuses on the identification of an internal process to ensure TVA has the needed capacity and organizational structures in order to effectively assess agency specific climate change risks and opportunities and implement appropriate adaptation actions.
	Action Goal	Process Assessment and Recommendations
	Agency Lead	Environment
	Risk or Opportunity	Efficient and effective oversight processes
	Scale	Regional
	Timeframe	FY2013-2015
	Implementation Methods	Creation and maintenance of high-level process map in FY2013. High-level process management review in FY2014-2015.
	Performance	Ongoing
	Inter-Governmental Coordination	None
	Resource Implications	TVA will be dedicating non-appropriated funds, as practicable.
	Challenges/Further Considerations	Organizational reorganization.
	Highlights of Accomplishments to Date	Process maps completed. High-level policy review ongoing.
Internal Adaptation Investment/ Action Barrier Assessment	**Action Description**	This action focuses on the high-level identification of barriers that discourage investments or other actions to increase the Nation's resilience to climate change while ensuring continued protection of public health and the environment.
	Action Goal	High-level identification of significant adaptation investment/action barriers
	Agency Lead	Environment
	Risk or Opportunity	More efficient and effective adaptation investment/action processes.
	Scale	Regional
	Timeframe	FY2014-FY2016
	Implementation	1) a description of any identified barriers;

	Methods	2) a brief statement of the rationale for identifying the circumstance as a barrier; 3) the type of action(s) that the agency believes are available to address the barrier and whether the action can be addressed exclusively by the agency or if others will need to be involved; 4) timing and expected timeframe for addressing the barrier; and 5) identification of any resources necessary to address the barrier.
	Performance	New
	Inter-Governmental Coordination	Potential
	Resource Implications	TVA will be dedicating non-appropriated funds, as practicable.
	Challenges/Further Considerations	Responses to: • E.O. 13653 State, Local and Tribal Leaders Task Force November 2014 Report; • E.O. 13653 Interagency Inventory and Assessment August 2014 Report.
	Highlights of Accomplishments to Date	TBD
Internal High-Level Agency Funding Assessment	**Action Description**	This action focuses on the high-level assessment of Agency funding programs that may, perhaps unintentionally, increase the vulnerability of natural or built systems, economic sectors, natural resources, or communities to climate change related risks.
	Action Goal	High-level identification of significant internal funding barriers.
	Agency Lead	Environment
	Risk or Opportunity	Efficient and Effective Adaptation Processes
	Scale	Regional
	Timeframe	FY2014-FY2016
	Implementation Methods	1) a description of any identified funding programs that may increase the vulnerability of natural or built systems, economic sectors, natural resources, or communities; 2) a brief statement of the rationale for identifying the policy or program as likely to increase vulnerability. 3) the type of action(s) that the agency believes are available to address the identified policies and programs and whether the action can be addressed exclusively by the agency or if others will need to be involved; 4) timing and expected timeframe for addressing identified concerns; and 5) identification of any resources necessary to resolve the concern
	Performance	New

	Inter-Governmental Coordination	Potential
	Resource Implications	TVA will be dedicating non-appropriated funds, as practicable.
	Challenges/Further Considerations	Responses to: • E.O. 13653 State, Local and Tribal Leaders Task Force November 2014 Report; • E.O. 13653 Interagency Inventory and Assessment August 2014 Report.
	Accomplishments to Date	TBD
Identification of Opportunities to Support and Encourage Climate Resilient Stakeholder Investment	**Action Description**	This action focuses on a high-level identification of opportunities to support and encourage smarter, more climate-resilient investments by States, local communities, and tribes, including by providing incentives through Agency guidance, grants, technical assistance, performance measures, safety considerations, and other programs.
	Action Goal	Identification of opportunities to support and encourage climate resilient stakeholder investment
	Agency Lead	Environment
	Risk or Opportunity	Efficient and Effective Adaptation Processes
	Scale	Regional
	Timeframe	FY2014-FY2016
	Implementation Methods	1) a description of any identified agency efforts to support and encourage smarter, more climate-resilient investments by States, local communities and tribes; 2) a brief statement on the rationale for identifying the policy or program as an opportunity; 3) the type of action(s) that the agency believes are necessary to ensure successful implementation of the opportunities and whether the action can be addressed exclusively by the Agency or if others will need to be involved; 4) timing and expected timeframe for implementing the opportunities; and 5) identification of any resources necessary for implementation.
	Performance	New
	Inter-Governmental Coordination	Potential

	Resource Implications	TVA will be dedicating non-appropriated funds, as practicable.
	Challenges/Further Considerations	Responses to: • E.O. 13653 State, Local and Tribal Leaders Task Force November 2014 Report; • E.O. 13653 Interagency Inventory and Assessment August 2014 Report.
	Accomplishments to Date	TBD
External Coordination Efforts	**Action Description**	This action focuses on the identification of an internal process to coordinate its adaptation planning with related efforts among state, local, tribal, and territorial partners. These efforts include TVA's Regional Resource Stewardship Council (RRSC) and TVA's Regional Energy Resource Council (RERC) as well as TVA participation in the Appalachian Land Conservation Cooperative (LCC) and the Southeast Climate Science Center (CSC).
	Action Goal	Efficient stakeholder project communication and coordination
	Agency Lead	Environment
	Risk or Opportunity	Efficient and effective oversight processes
	Scale	Regional
	Timeframe	FY2013-FY2015
	Implementation Methods	Creation and maintenance of a high-level process map; Creation and maintenance of external adaptation project coordination table
	Performance	Ongoing
	Inter-Governmental Coordination	Project Dependent
	Resource Implications	TVA will be dedicating non-appropriated funds, as practicable.
	Challenges/Further Considerations	Organizational reorganization.
	Highlights of Accomplishments to Date	Creation of TVA's Regional Energy Resource Council (RERC).

Dry Ash Handling and Storage	**Action Description**	TVA has developed plans to eliminate all wet ash and gypsum storage at its operating coal-fired power plants and convert the ash and gypsum systems to dry storage. The movement away from wet fly ash systems will help to reduce the overall use of water in TVA's power generation facilities and help to meet sustainability goals as required by Executive Order 13514.
	Action Goal	Eliminate power generation wet fly ash systems and

		reduce water use.
	Agency Lead	Environment
	Risk or Opportunity	Water availability and use
	Scale	Regional
	Timeframe	FY2010-FY2020
	Implementation Methods	TVA is committed to better management and use of potable and non-potable water resources. TVA's work to eliminate wet ash handling and storage will cut non-potable water use by 13% by FY2012 and 11% by FY2013.
	Performance	Ongoing
	Inter-Governmental Coordination	TVA is coordinating this work with the DOE Federal Energy Management Program (FEMP) and reporting progress through its Annual Report on Energy Management and OMB Scorecard.
	Resource Implications	TVA expects the overall program to cost $1.5 to $2 billion. TVA will be dedicating non-appropriated funds, as practicable, at its discretion.
	Challenges/Further Considerations	Achievement of the goal is contingent upon TVA Board approval of individual ash/gypsum dewatering projects.
	Highlights of Accomplishments to Date	TVA has already shown a reduction of 949 million gallons of non-potable water in FY2011. The target for 2020 is 23,000 million cumulative gallons of reduced non-potable water consumption.
Greenhouse Gas Reduction	**Action Description**	TVA's Environmental Policy states the environmental objective that TVA "will stop the growth of emissions and reduce the rate of carbon emissions by 2020 by supporting a full slate of reliable, affordable, lower CO_2 energy-supply opportunities and energy efficiency." With EPA agreements and its own long-range plans, TVA has announced plans to retire 18 older coal-fired generation units at three power plants. The retirements, which include about 1,000 megawatts of coal-fired capacity previously slated for idling, meaning TVA will have idled or retired about 2,700 megawatts of its 17,000 megawatts of coal-fired capacity by the end of 2017. The capacity will be replaced with low-emission or zero-emission electricity sources, including renewable energy, natural gas, nuclear power, and energy efficiency. In accordance with EO 13514, TVA has set additional GHG reduction targets for Scope 1, Scope 2 and Scope 3 activities and annually reports its progress as part of its Strategic Sustainability Performance Plan. TVA has developed plans to reduce Scopes 1 and Scope 2 greenhouse gas (GHG) emissions through facility energy reductions, and use of renewable energy. TVA has developed plans to reduce Scope 3 Greenhouse Gas emissions through energy reductions in leased facilities (not included in Scopes 1 and Scope 2), reduction in business travel and employee commuting, reductions in transmission and distribution losses associated with Scope 2 energy and reductions in solid/liquid waste. These actions will also help to meet sustainability goals identified by E O 13514.

	Action Goal	GHG emissions mitigation
	Agency Lead	TVA's Internal Energy Management Program
	Risk or Opportunity	Opportunity is a reduction in GHG emissions which could reduce the impacts of climate change.
	Scale	Regional. Scope 1 and Scope 2 Targets are a 17% reduction. Scope 3 Target is a 20.7% reduction.
	Timeframe	FY2008 to FY2020
	Implementation Methods	TVA is committed to reduction in energy used to power buildings and fuel vehicles. FY2013 Targets are a 9.8% reduction in Scope 1& Scope 2 GHG emissions and a 6.7% reduction in Scope 3 emissions
	Performance	Ongoing
	Inter-Governmental Coordination	TVA is coordinating this work with the DOE Federal Energy Management Program (FEMP) and reporting progress through its Annual Report on Energy Management and OMB Scorecard.
	Resource Implications	TVA plans to spend $17 million FY 2012 – FY 2013. TVA will be dedicating non-appropriated funds, as practicable, at its discretion.
	Challenges/Further Considerations	Organizational reorganization
	Highlights of Accomplishments to Date	TVA has been working to reduce energy use in its facilities since the late 70's. To date TVA facilities use almost half the energy of the average Federal building energy use.

LIST OF ABBREVIATIONS/TERMS

CCAAP – Climate Change Adaptation Action Plan

CO2 – Carbon Dioxide

CSC – Southeast Climate Science Center

DOE – Department of Energy

EIS – Environmental Impact Statement

EO – Executive Order

EO 13653—November 6, 2013 Executive Order, Preparing the United States for the Impacts of Climate Change

EO 13514 – October 5, 2009 Executive Order, Federal Leadership in Environmental, Energy, and Economic Performance

EP – Environmental Policy

EPRI - Electric Power Research Institute

FACA – Federal Advisory Council Act

FEMP – Federal Energy Management Program

FWS – U.S. Fish and Wildlife Service

GHG – Greenhouse Gas

IRP – Integrated Resource Plan

LCC – Appalachian Land Conservation Cooperative

LPC – Local Power Company

OMB – Office of Management and Budget

ORNL - Oak Ridge National Laboratory

NCA – U. S. National Climate Assessment

NEPA – National Environmental Policy Act

NGO – Non-Governmental Organization

NRP – Natural Resource Plan

NPS – National Park Service

RERC – Regional Energy Resource Council

ROS – River Operations Study

RRSC – Regional Resource Stewardship Council

SMP – Shoreline Management Policy

SMR – Small Modular Reactor

Smart Grid – Grid Modernization

SSPP – Strategic Sustainability Performance Plan

TVA - Tennessee Valley Authority

USGCRP – U.S. Global Change Research Program

8-K – Current Reports filed with Security Exchange Commission

10-K – Annual Report filed with Security Exchange Commission

10-Q – Quarterly Reports filed with Security Exchange Commission

NOTES

[i] *Instructions for Implementing Climate Change Adaptation Planning in Accordance with Executive Order 13514*, *Support Document,* CEQ, March 4, 2011, p. 8. *See* http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_support_document_3_3.pdf

[ii] Federal Register, 74 FR 52117-52127, October 8, 2009. See http://www.gpo.gov/fdsys/pkg/FR-2009-10-08/pdf/E9-24518.pdf

[iii] Federal Register, 78 FR 66819-66824, November 6, 2013. See http://www.gpo.gov/fdsys/pkg/FR-2013-11-06/pdf/2013-26785.pdf.

[iv] TVA Natural Resource Plan, p 16. The *Draft National Ocean Policy Implementation Plan* strongly communicates the importance of observations from the Nation's protected areas, research sites, and observing systems into a coordinated network of sentinel sites, concluding that integrating observations is essential to advancing our understanding of how communities and ecosystem respond and adapt to climate change.

[v] *Id.*

[vi] TVA's 2013 10-K, p 27.

[vii] As reported in TVA's 2013 10-K. p 12.

[viii] More information about TVA's generation facilities can be found at: http://www.tva.com/power/index.htm.

[ix] As reported in TVA's 2013 10-K, p 19.

[x] As reported in TVA's 2013 10-K, p 23.

[xi] As reported in TVA's 2013 10-K p 20.

[xii] As reported in TVA's 2013 10-K, p 25.

[xiii] As reported in TVA's 2013 10-K, p 26.

[xiv] TVA's 2013 10-K, p 25.

[xv] TVA has participated in the National Atmospheric Deposition Program since the early 1980's to evaluate acidic deposition in precipitation.

[xvi] TVA has partnered with the National Park Service to better understand air quality in Great Smoky Mountains National Park.

[xvii] EO 13653, (Federal Register, 78 FR 66822, 11/06/2013). See http://www.gpo.gov/fdsys/pkg/FR-2013-11-06/pdf/2013-26785.pdf.

[xviii] Dell, J., S. Tierney, G. Franco, R. G. Newell, R. Richels, J. Weyant, and T. J. Wilbanks, 2014: Ch. 4: Energy Supply and Use. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 113-129. doi:10.7930/J0BG2KWD. [Available online at http://nca2014.globalchange.gov/report/sectors/energy]. , p 117. Climate change-related increase in demand could also be exacerbated by a number of ongoing trends, such as population growth and increased building sizes. GAO, *Climate Change, Energy Infrastructure Risks and Adaptation Efforts*, GAO-14-74, January 2014.

[xix] *Id.*

[xx] Kunkel, K.E., L.E. Stevens, S.E. Stevens, L. Sun, E. Janssen, D. Wuebbles, C.E. Konrad II, C.M. Fuhrman, B.D. Keim, M.C. Kruk, A. Billet, H. Needham, M. Schafer, and J.G. Dobson, 2013; Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 2. Climate of the Southeast U.S. NOAA Technical Report 14202, 103 pp., National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington D.C. [available online at http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-2-Climate_of_the_Southeast_U.S.pdf]. p 83.

[xxi] Dell, J., S. Tierney, G. Franco, R. G. Newell, R. Richels, J. Weyant, and T. J. Wilbanks, 2014: Ch. 4: Energy Supply and Use. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 113-129. doi:10.7930/J0BG2KWD, p 117.

[xxii] NASA NEX-DCP30. Maximum Temperature, Mean Model, 50% percentile (all months), RCP 4.5 (2.9°F) and RCP8.5 (3.02). Minimum temperature, Mean Model, (all months) RCP 4.5 (2.7°F) and RCP 8.5 (2.93°F).
[xxiii] These ranges reflect different assumptions about factors such as the rate of market penetration of improved building equipment technologies. *Global Climate Change Impacts In the United States*, U.S. Global Change Research Program, 2009. *See* http://downloads.globalchange.gov/usimpacts/pdfs/health.pdf.
[xxiv] GAO, *Climate Change, Energy Infrastructure Risks and Adaptation Efforts,* GAO-14-74, January 2014, p 20. Warming temperatures may decrease the efficiency of power plant cooling technologies, thereby reducing overall electricity generation. While the magnitude of these effects will vary based on a number of plant-and site-specific factors even small changes in efficiency could have significant implications for electricity supply at a national scale. *Id* at 20-21.

[xxv] *Id.* According to the Congressional Research Service, the energy sector is the fastest growing water consumer in the United States and is projected to account for 85% of the growth in domestic water consumption between 2005 and 2030. This increase in water use associated with energy development is being driven, In part, by rising energy demand, increased development of domestic energy, and shifts to more water-intense energy sources and technologies. *Id* at p 28. USGCRP and NRC assessment project that water issues will continue to constrain electricity production at existing facilities as temperatures increase and precipitation patterns change. Many of these risks are regional in nature; research by the Electric Power Research Institute (EPRI), for example, indicates that approximately 25% of existing electric generation in the United States is located in counties projected to be at high or moderate water supply sustainability risk in 2030. GAO, *Climate Change: Energy Infrastructure Risks and Adaptation Efforts*, GAO-14-74, January 2014, p 20. EPRI, 2011. *Water Use for Electricity Generation and Other Sectors: Recent Changes (1985-2005) and Future Projections (2006-2030).* 1023676. Palo Alto, CA: Electric Power Research Institute (November 10, 2011). Since 2009, GAO has issued five reports on the interdependencies that exist between energy and water. GAO, *Energy-Water Nexus: Improvements to Federal Water Use Data Would Increase Understanding of Trends in Power Plant Water Use*, GAO-10-23 (Washington, D.C.: Oct. 16, 2009); GAO, *Energy-Water Nexus: Many Uncertainties Remain about National and Regional Effects of Increased Biofuel Production on Water Resources*, GAO-10-116 (Washington, D.C.: Nov 30, 2009); GAO, *Energy-Water Nexus: Among of Energy Needed to Supply, Use, and Treat Water is Location-Specific and Can Be Reduced by Certain Technologies and Approaches*. GAO-11-225 (Washington, D.C.: March 23, 2011); GAO, *Energy-Water Nexus: A Better and Coordinated Understanding of Water Resources Could Help Mitigate the Impacts of Potential Oil Shale Development*, GAO-11-35 (Washington, D.C.: Oct 29, 2010)' and GAO, *Energy-Water Nexus: Information on the Quantity, Quality and Management of Water Produced during Oil and Gas Production*, GAO-12-156 (Washington, D.C. Jan 9, 2012).
[xxvi] Georgakakos, A., P. Fleming, M. Dettinger, C. Peters-Lidard, Terese (T.C.) Richmond, K. Reckhow, K. White, and D. Yates, 2014: Ch. 3: Water Resources. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 69-112. doi:10.7930/ J0G44N6T.p 89. GAO, Climate Change: Energy Infrastructure Risks and Adaptation Efforts, GAO-14-74, January 2014. P 19.
[xxvii] Milly, P.C.D., J. Betancourt, M. Falkenmark, R.M. Hirsch, Z.W. Kundzewicz, D.P. Lettenmaier, and R.J. Stouffer, 2008: Stationarity is dead: Whither water management? *Science*, **319(5863)**, 573-574.
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[xxx] *1988 Sensitivity Study* at 64.

[xxxi] *Id.*

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[xxxix] *Id. See also, Miller,* B.A, V. Alavian, M.D. Bender, D.J. Benton, L.L. Cole, L.K. Ewing, P.Ostrowski, N.A. Nielsen, J.A. Parsly, W.B. Proctor, H.M. Samples, M.C. Shaio, R.A. Shinn, *Sensitivity of the TVA Reservoir and Power Supply Systems to Extreme Meterology*, WR28-1-680-111, TVA Engineering Laboratory, Norris, TN, (June 1993).

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[xli] *Southeast and the Caribbean, of the Federal Advisory Committee Draft Climate Assessment Report Released for Public Review* (volume 11 Jan 2013) *see*: http://ncadac.globalchange.gov/

[xlii] *Southwest Region Technical Report to the National Climate Assessment (Revised July 23, 2012)* available at http://downloads.usgcrp.gov/NCA/Activities/NCA_SE_Technical_Report_FINAL_7-23-12.pdf.

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[xlv] In 1978, 44% of households were without air conditioning, whereas in 2005, only 16 percent of the U.S. population lived without it (and only 3 percent did not have it in the South). *Id*.

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