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TVA POWER SUPPLY FLEXIBILITY PROPOSAL
DRAFT ENVIRONMENTAL ASSESSMENT

Prepared for:
Tennessee Valley Authority
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SYMBOLS, ACRONYMS, AND ABBREVIATIONS

AC	Alternating current
BTU	British Thermal Unit
CAA	Clean Air Act of 1970
CC	Combined cycle
CCR	Coal combustion residuals
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CHP	Combined Heat and Power
CO	Carbon monoxide
CO_2	Carbon dioxide
CWA	Clean Water Act
DC	Direct current
DER	Distributed energy resources
EA	Environmental Assessment
EE	Energy efficiency
EIS	Environmental Impact Statement
EO	Executive Order
EUC	End-use consumer
FRP	Flexibility Research Project
FY	Fiscal year
GHG	Greenhouse gas
GWh	gigawatt-hour
HAP	Hazardous air pollutant
IRP	Integrated Resource Plan
kWh	Kilowatt-hour
LPC	Local power company
LTP	Long-Term Partnership
MSA	Metropolitan Statistical Area
MW	Megawatt
MWh	Megawatt hour
NAAQS	National Ambient Air Quality Standards
NEI	National Emission Inventory
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
O_3	Ozone
$PM_{2.5}$	Particulate matter whose particles are less than or equal to 2.5 micrometers
PM_{10}	Particulate matter whose particles are less than or equal to 10 micrometers
PPA	Power purchase agreement

PSA	Power service area
PV	Photovoltaic
RCRA	Resource Conservation and Recovery Act
REC	Renewable Energy Certificate
RICE	Reciprocating internal combustion engine
SO_2	Sulfur dioxide
TDEC	Tennessee Department of Environment and Conservation
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
U.S.	United States
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USDOE	U.S. Department of Energy
USEIA	U.S. Energy Information Administration
USEPA	U.S. Environmental Protection Agency

CHAPTER 1 – PURPOSE AND NEED FOR ACTION

1.1 Proposed Action

The Tennessee Valley Authority (TVA) is proposing to provide enhanced power supply flexibility to local power companies (LPCs) within their respective Power Service Area (PSA; Figure 1) that have entered into Long-Term Partnership (LTP) agreements with TVA. Under the terms of the LTP resolution approved by the TVA Board of Directors in August 2019, LPCs that enter into an LTP agreement ("Valley Partners") would be offered the option to generate a portion of their customers' power requirements.

1.2 Purpose and Need for Action

TVA is a self-financed, wholly owned corporate agency of the United States that serves a region that consists of parts of seven southeastern states. As a public power entity, TVA has no shareholders and receives no tax dollars. Under the TVA Act of 1933, as amended (the TVA Act), Congress charged TVA with advancing the social and economic welfare of the residents of the Tennessee Valley region. One of the most important ways that TVA fulfills its congressional mandate is by providing reliable, affordable electric power to its 154 municipal and cooperative LPCs. LPCs take delivery of electricity generated and transmitted by TVA and perform the distribution function for their approximately 10 million retail consumers of electricity. TVA also sells power to 58 directly served retail customers with large or unusual power requirements. TVA is mandated to provide power at rates as low as feasible.

The LTP agreements strengthen the contractual relationships between LPCs and TVA and ensure continued success of the public power model. The proposed action would implement the flexibility benefit of the August 2019 Board resolution ("Flexibility Proposal"). In the Flexibility Proposal, TVA committed to develop an option for power supply flexibility for Valley Partners to generate up to five percent of energy, by October 1, 2021. If TVA does not provide an agreeable power supply flexibility option by the specified date, LPCs have the option to terminate their LTP agreement.

TVA would benefit from the Flexibility Proposal because it would enhance the Valley's energy resource diversity and would be responsive to customer demand for renewable energy resources. These are objectives identified by TVA in its 2019 Integrated Resource Plan (IRP; TVA 2019a). The Valley benefits from a diverse power system. As the economics of renewables and distributed energy resources (DER) continue to improve, operational agility will be increasingly important to successful integration of these resources into the generation portfolio. The five percent flexibility level would provide Valley Partners sufficient flexibility to meet their customers' needs while ensuring that the financial health impact to TVA is at a level that fits within the current strategic financial plan.

Current wholesale power contracts between TVA and LPCs require that LPCs obtain their entire power requirements from TVA. For many years, LPCs have requested the flexibility to generate power. LPCs have indicated that some customers turn to third-party providers for generation services because the current wholesale power contract restricts the LPCs from providing those same services. Under the Flexibility Proposal, TVA would remain the full requirements provider, but Valley Partners would be allowed to provide generation services to their retail customers so as to remain their customers' trusted energy advisor and comprehensive power supplier. The proposal would potentially reduce costs for customers seeking generation solutions and would address customer demands for reductions of their carbon footprints.

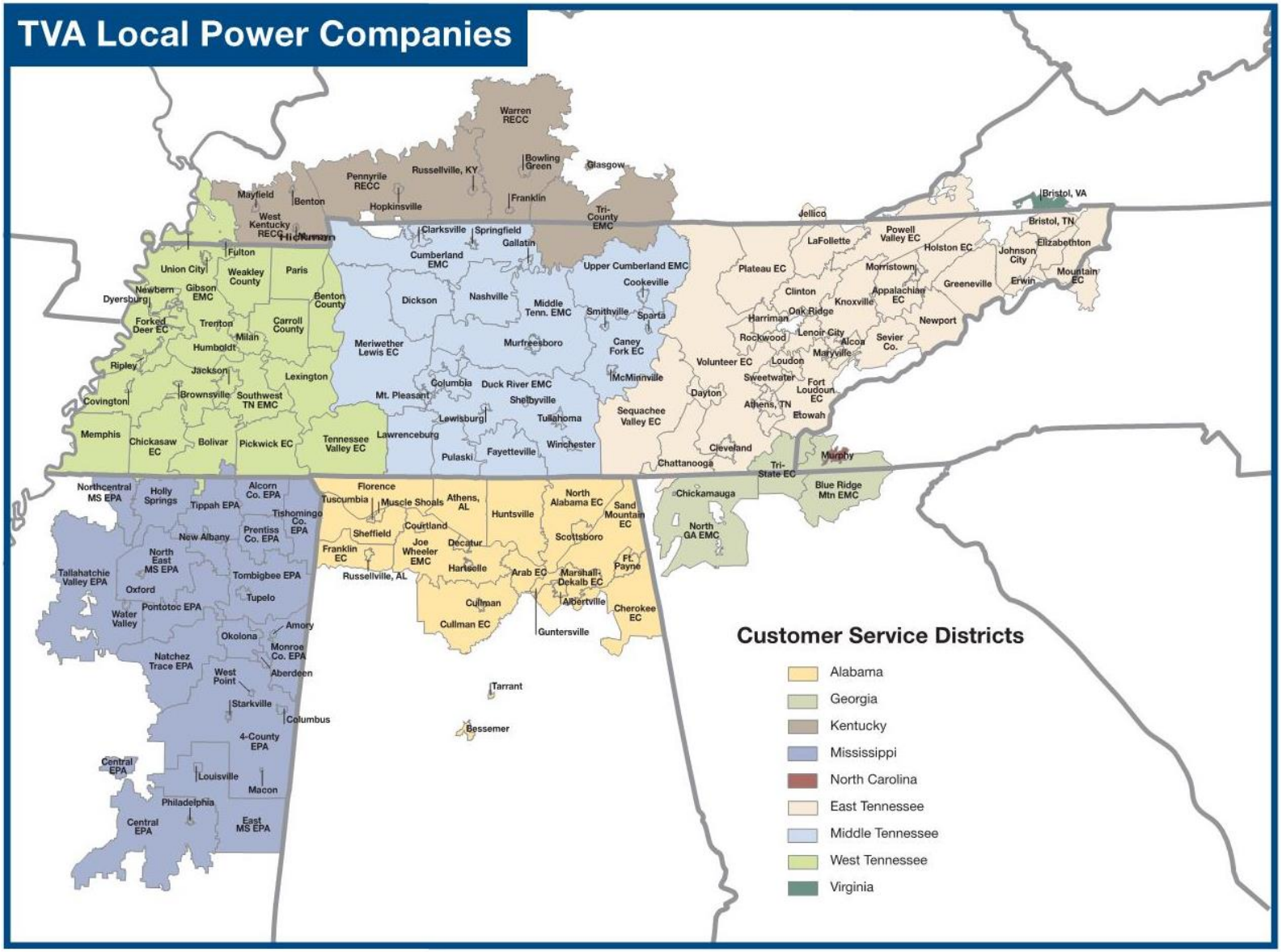

Figure 1. Map of the TVA Power Service Area and Local Power Companies

Additionally, the Flexibility Proposal would allow some LPCs to lower their wholesale power costs through the reduction of monthly demand and energy charges.

1.3 Background

As noted above, the TVA Board approved the Long-Term Partnership Agreement Resolution on August 22, 2019. The LTP agreements strengthen the contractual relationships between LPCs and TVA and secure the benefits of the public power model for decades to come. Key elements of the LTP agreements are long-term commitments, a bill credit, rate adjustment protection, input to long-term planning, and power supply flexibility:

1. The long-term commitment established a 20-year term and termination notice requirement for the existing evergreen contracts between TVA and the LPCs. Previously, wholesale power contracts between TVA and individual LPCs had termination notice periods ranging from 5 to 20 years.
2. The partnership credit is based on the value of the long-term commitment to specific base charges. The credit is currently 3.1 percent applied to the base rate charges of the monthly wholesale power bills of Valley Partners.
3. Under the LTP agreements, if TVA implements rate increases to wholesale base rates that exceed thresholds specified in the agreements, Valley Partners may renegotiate the terms of, or withdraw from, the LTP agreement.
4. TVA has established a process of engagement with Valley Partners to gain input on strategic resource and financial planning decisions.
5. TVA committed to delivering an option for power supply flexibility for Valley Partners to generate up to five percent of energy by October 1, 2021. The proposed action would implement the Flexibility Proposal. If TVA does not deliver a satisfactory power supply flexibility option by the specified date, LPCs have the option to terminate their LTP agreement.

TVA has previously worked with LPCs to address the demand for flexible generation. TVA implemented a flexibility option consistent with the TVA public power model, known as the Flexibility Research Project (FRP). The FRP was approved to meet consumer demand consistent with the all-requirements wholesale power contracts between TVA and LPCs on a demonstration basis, enabling both TVA and LPCs to evaluate the potential of such projects and assess system impacts. The FRP allows LPCs to build, own, and operate generation while maintaining buy-all/sell-all relationships. Up to 300 MW of flexible generation from solar, combined heat and power, and other applicable technologies is available to LPCs under the FRP. This option is open to all LPCs, regardless of whether they choose to become Valley Partners, until January 2021. The FRP does not provide the same reductions to monthly billing determinants as the Flexibility Proposal, but is instead a modified power purchase agreement under which TVA purchases the power generated by the LPCs. Agreements under the FRP have delivery durations limited to 20 years. To date, no FRP projects have been brought into operation.

1.4 Proposed Decision

TVA must assess the impact of its proposed action to provide power supply flexibility to its Valley Partners under the terms of the LTP agreements. The assessment of the No Action alternative provides a benchmark against which to assess the impacts of the proposed action. The two alternatives are presented in Chapter 2.

1.5 Other Pertinent Environmental Reviews or Documentation

Pursuant to the National Environmental Policy Act (NEPA) of 1969 and its implementing regulations promulgated by the Council on Environmental Quality (40 Code of Federal Regulations §§ 1500-1508), federal agencies are required to evaluate the potential environmental impacts of their proposed actions. TVA has prepared this Environmental Assessment (EA) pursuant to NEPA and TVA's procedures for implementing NEPA (TVA 1983) to assess potential impacts associated with approval of the Flexibility Proposal. This EA tiers from the 2019 IRP Environmental Impact Statement (EIS) (TVA 2019a) and relies in part on that EIS analysis. Because the Flexibility Proposal establishes a "program" applying to any LPC that has a long-term agreement with TVA, the EA's analysis is largely generic in nature as site-specific information about the location or type of power generation resource LPCs would utilize is unknown.

Tiering to the 2019 IRP EIS allows TVA to rely on the assessment in that EIS for alternatives within the IRP Power Target Supply Mix decision. It allows TVA to tier its analysis to address more site-specific impacts that may occur based on likely LPC deployment scenarios. The 2019 IRP EIS did not provide general information about generating resources of the scale contemplated in the Flexibility Proposal. Diesel and coal generation would be inconsistent with the 2019 IRP and nuclear generation at that scale would not likely be feasible.

The potential for expansion of DER within the TVA PSA was a key focus area in the development of TVA's 2019 IRP, which was approved by the TVA Board in August 2019. The IRP process evaluates TVA's current energy resource portfolio and alternative future portfolios of energy resource options on a "lowest system cost" basis to meet the future electrical energy needs of the TVA region (TVA 2019a).

Several combinations of scenarios (plausible futures outside TVA's control) and strategies (alternative business approaches within TVA's control) were evaluated in the 2019 IRP. TVA considered the promotion of DER most explicitly under Strategy B ("Promote DER"). Under that strategy, TVA would focus on increasing the pace of DER adoption by incentivizing distributed solar generation and storage, combined heat and power, energy efficiency, and demand response. High penetration of distributed generation was also considered under the different scenarios evaluated in the IRP (TVA 2019a).

The Final IRP incorporated a Target Power Supply Mix as the preferred generation portfolio mix that incorporates expansion of DER across the TVA region. While the IRP accounted for DER growth in the Valley by considering distributed generation and storage as resource options, it did not set specific capacity ranges for the expansion of DER or address specific programs that would implement distributed generation offerings by TVA and/or LPCs. Those programs were identified as implementation-level considerations and policy considerations that would be addressed later in time (TVA 2019a).

The programmatic analysis in the 2019 IRP EIS broadly addresses the potential impacts of future TVA power generation over the 20-year planning period. The analysis in the IRP EIS first describes the general process TVA uses to site new power facilities. It then describes the potential environmental impacts of the continued operation of TVA's generating facilities, facilities from which TVA purchases power through Power Purchase Agreements (PPAs), and the generating facilities that TVA is likely to own or purchase power from in the future. The EIS then describes the environmental impacts of energy efficiency programs and demand response programs (TVA 2019a).

In September 2014, TVA completed a Solar Photovoltaic Projects Programmatic EA addressing the potential impacts of constructing and operating small solar photovoltaic (PV) systems that provide power for the TVA system. The EA addressed greenfield solar facility development of sites covering up to 10 acres (generating approximately one to two megawatts [MW]) and brownfield development of sites covering up to 20 acres (generating approximately three to four MW) (TVA 2014).

1.6 Public Involvement

TVA is issuing the draft EA for a 30-day public review to allow the general public an opportunity to review and comment on TVA's proposed action. TVA will consider the public comments in completing the final EA. Because there are no state or federal permits or licenses required of TVA to undertake this action, TVA has not consulted with other agencies relating to the proposal.

1.7 Necessary Permits or Licenses

There are no state or federal permits or licenses required for TVA to undertake this action. Under the terms of the proposed action, LPCs or other project owners/operators would be responsible for obtaining the appropriate state and federal permits associated with the construction and operation of any generating facilities necessary to implement the Flexibility Proposal.

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CHAPTER 2 – ALTERNATIVES

This chapter describes the alternatives analyzed in this EA, summarizes the environmental impacts associated with each alternative, identifies potential mitigation measures, and presents the preferred alternative.

2.1 Description of Alternatives

2.1.1 No Action Alternative

The No Action Alternative provides a baseline of conditions against which the impacts of the Proposed Action Alternative are measured. Under the No Action Alternative, TVA would continue to implement the LTP agreements and would continue to offer the FRP as a flexibility option until January 2021. To date, no FRP projects have been brought into operation. Valley Partners would continue to rely on TVA for their entire power requirements. The Valley Partners would have the contractual option to terminate their LTP agreements after October 1, 2021.

2.1.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would establish new agreements ("Flexibility Agreements") with LPCs that are Valley Partners to provide power supply flexibility, based on the following principles:

- Valley Partners could have flexible generation of up to five percent of their average total hourly energy sales over the last five TVA fiscal years (FY 2015 to 2019), converted to capacity basis with a minimum availability of one MW per Valley Partner. TVA would calculate each LPC's average hourly wholesale load over the last five TVA fiscal years, multiplied by five percent. The calculated amount would never decrease for Valley Partners. A total of approximately 800 MW could be developed if all 154 LPCs across the Valley participate and develop their maximum allowable capacity. The largest LPCs have potential flexible generation of 70 to 80 MW, while 24 small LPCs have potential flexible generation of the 1 MW minimum.
- Flexible generation would be distribution scale[1] and located within the LPC service territory, except when circumstances such as restrictive siting can be demonstrated. Valley Partners would not be required to own or operate flexible generation assets themselves. LPCs could use a combination of different forms of generation.
- Flexible generation would be documented, metered, operated, and connected in a manner consistent with TVA standards. The Valley Partner would provide the location, fuel source, operating characteristics, and the maximum net capability of the flexible generators to TVA. TVA and Valley Partners would ensure the flexible generation projects are interconnected in a safe and reliable manner.
- Flexible generation would reduce monthly demand and energy billing determinants or would be treated in accordance with an economically equivalent crediting mechanism; generation would only serve to reduce the amount of power and energy that would have otherwise been supplied to the LPC by TVA, but TVA will remain obligated to provide the full power requirements of the Valley Partner. The flexible generation would reduce

[1] Distribution scale generation generally refers to generation that LPCs may install within their five percent limitation and distribute within their service territory to end use customers.

monthly wholesale billing determinants during the month of generation for the term of the Flexibility Agreement. The pricing of flexible generation would be the prevailing wholesale rate.

- Flexible generation would be consistent with TVA's IRP to ensure that TVA's carbon position is improved. Consistent with DER identified in the 2019 IRP, community solar, rooftop solar, co-located solar and battery installations, natural gas-fired generators, and high efficiency natural gas-fired combined heat and power projects would be eligible. Diesel-fired or coal-fired generation technologies would not be eligible, due to their omission from the Target Power Supply Mix identified in the 2019 IRP.

As long as Valley Partners adhere to the above principles and the contract, which is built around these principles, TVA would not oversee or have approval authority over the generation resources acquired or constructed by Valley Partners. TVA would not conduct additional site-specific review of new facilities.

2.1.3 Other Alternatives Considered but not Carried Forward

During the development of the Proposed Action Alternative, TVA considered other alternatives. However, upon further study, TVA determined that these other alternatives were not feasible for the reasons provided below.

2.1.3.1 Flexible Generation of Greater than Five Percent

TVA considered allowing Valley Partners to have flexible generation of greater than five percent of their average total hourly energy sales over the last five TVA fiscal years. When developing the LTP agreement, TVA determined that the range of three to five percent balanced the risk of revenue erosion with the expected benefits of rate and financial stability from longer commitment periods, and moves this new concept gradually. Additionally, TVA determined that while five percent power supply flexibility would provide LPCs with substantially more flexibility than three percent, any flexibility greater than five percent would impose a higher risk to the financial plan. For these reasons, this alternative was eliminated from further consideration.

2.1.3.2 Expansion of the TVA Flexibility Research Project

TVA considered expanding its Flexibility Research Project, a flexibility option consistent with the TVA public power model that was implemented by TVA in 2019. The FRP was approved to meet consumer demand consistent with the all-requirements wholesale power contracts between TVA and LPCs on a demonstration basis to enable both TVA and LPCs to evaluate the potential of such projects and to assess system impacts. The FRP allows LPCs to build, own, and operate generation while maintaining buy-all/sell-all relationships. Up to 300 MW of flexible generation from solar, combined heat and power, and other applicable technologies has been available to LPCs under the FRP. An expanded option could match the 800 MW of flexible generation considered under the Flexibility Proposal. This option is and would remain open to all LPCs until January 2021 regardless of their choice to become Valley Partners. However, the FRP does not provide the same reductions to monthly billing determinants as the Flexibility Proposal but instead involves a modified power purchase agreement under which TVA purchases the power generated by the LPCs. Agreements under the FRP have delivery durations limited to 20 years. The FRP remains poorly subscribed and has not yet seen any projects brought into operation. For these reasons, this alternative was eliminated from further consideration.

2.2 Comparison of Alternatives

This EA evaluates the potential environmental effects that could result from implementing the No Action Alternative or the Proposed Action Alternative. The analysis of impacts in this EA is based on the current and potential future conditions throughout the TVA PSA. Most of the impacts of the Proposed Action Alternative are indirect impacts that would result from the actions of participating LPCs through their construction and operation of flexible generation. A comparison of the impacts of the alternatives is provided in Table 1.

Table 1. Comparison of Impacts by Alternative

Resource Area	Impacts by Alternative	
	No Action Alternative	**Proposed Action Alternative**
Energy Production and Use	No direct or indirect impacts anticipated.	Negligible change in energy production and use due to the relatively small proportion of TVA's overall generating capacity that would be provided by LPCs under the Proposed Action.
Socioeconomics	No direct or indirect impacts anticipated.	Beneficial impacts to customers of participating LPCs. Short-term beneficial economic impacts would result from construction of generation facilities, including the purchase of materials, equipment, and services and a temporary increase in employment, income, and population. Temporary, minor adverse noise impacts to minority and low-income populations could occur during the construction and operation of natural gas-fired generation facilities.
Air Resources	No direct or indirect impacts anticipated.	Temporary emissions of air pollutants and GHG expected during construction would be negligible; long-term beneficial impacts to air quality are anticipated due to the overall reduction of emissions.
Water Resources	No direct or indirect impacts anticipated.	Any system-wide change in water usage and wastewater discharges would be negligible.
Land Resources	No direct or indirect impacts anticipated.	Minor indirect adverse impacts on land resources are anticipated.
Waste Generation	No direct or indirect impacts anticipated.	No adverse impacts to waste management are anticipated with the use of best management practices.

2.3 Identification of Mitigation Measures

TVA has not identified any mitigation measures necessary to offset or reduce the impacts of the alternatives.

2.4 The Preferred Alternative

TVA's preferred alternative for fulfilling its purpose and need is the Proposed Action Alternative.

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CHAPTER 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the existing environmental, social, and economic conditions of the Project and the surrounding areas that may be affected if the No Action Alternative or Proposed Action Alternative is implemented. This chapter also describes the potential environmental effects that could result from implementing the No Action Alternative or Proposed Action Alternative.

3.1 Framework for Environmental Impact Analyses

In order to develop a more robust impact analysis, TVA has made reasonable assumptions concerning the types and scale of flexible generation that LPCs are likely to deploy. These assumptions support TVA's analysis and are based on discussions with LPCs and end-use customers, industry trends, and input TVA received during the development of the IRP. While it is uncertain at this time whether all 154 LPCs will choose to become Valley Partners, the analysis in this EA is based on the assumption that all LPCs would do so. Thus, the analysis assumes a total of approximately 800 MW of flexible generation, and therefore, represents a description of the maximum potential impacts of flexible generation. The types of flexible generation are likely to vary among LPCs due to their different system requirements, customer preferences, and other factors. In order to encompass the potential range of variability, this EA analyzes three deployment scenarios:

Deployment Scenario 1: 100 percent solar;

Deployment Scenario 2: 90 percent solar and 10 percent natural gas-fired generation; and

Deployment Scenario 3: 50 percent solar and 50 percent natural gas-fired generation.

The three deployment scenarios bound the range of the proportions of solar and natural gas-fired generation that is likely and that would ensure that TVA's carbon position is improved. Based on discussions with participating LPCs, TVA considers Deployment Scenario 2 to be the most likely deployment scenario.

Potential solar installations are expected to utilize various configurations of PV panels, including ground-mounted multi-MW and smaller 1-MW installations on fixed-tilt and single-axis tracking mounting racks; rooftop-mounted, sub-1-MW installations on commercial and industrial buildings; and dispersed small residential installations. Rooftop-mounted installations require no additional land. Based on characteristics of recently constructed and proposed solar installations in the TVA region and elsewhere in the southeast, ground-mounted installations require an average of about 7.2 acres/MW_{AC} (6.1 acres/MW_{DC}) for fixed-tilt systems and 8.6 acres/MW_{AC} (7.3 acres/MW_{DC}) for single-axis tracking systems (TVA 2019a). Generally, developable sites must be relatively flat, not shaded by trees or tall buildings, and preferably close to an LPC's electrical transmission or distribution line that will connect to the facility. Construction activities include clearing the site of tall vegetation, grading as necessary to have a flat site profile, installation of electrical cables in trenches to connect arrays of PV panels, DC to AC inverters and power transformers, installation of metal mounting racks supported by metal posts driven into the ground by drilling or use of a pile driver, fastening PV panels to mounting racks, enclosing the site with security fencing, revegetating the site with low-growing vegetation, and connecting the facility to the LPC's electrical system.

Most existing and proposed solar installations in the TVA region have been constructed on land that was previously farmed. A small proportion (less than 3 percent) are on previously developed, brownfield sites including closed landfills and former industrial facilities. Solar facilities developed on these sites typically require special mounting racks that do not penetrate the ground surface and increase their development costs.

Some solar generation is likely to be community solar, which is targeted at residential and commercial customers interested in solar power but which, for various reasons, they are unable or unwilling to install on their own. These customers could participate in a variety of financial structures, but generally would purchase a portion of a solar facility constructed and operated by the LPC and receive a credit on their subsequent power bills proportional to the amount of solar energy generated through their investment in the community solar facility. Ten LPC-operated community solar facilities are currently operating in the PSA. The individual facilities range from 0.025 to 4.25 MW_{AC} in capacity.

Potential natural gas-fired generation installed under the Flexibility Agreements are expected to be stand-alone systems operated primarily during times of peak demand, or combined heat and power (CHP) systems.

Stand-alone systems would likely be reciprocating internal combustion engine (RICE) generator sets, which utilize a multiple-cylinder spark-ignition engine to drive a generator. RICE generator sets are available in a range of sizes up to about 20 MW capacity. Multiple generator sets can be co-located to provide increased capacity. Many models can be configured to operate on renewable landfill gas or digester gas. RICE generator sets are typically installed in buildings with, depending on the local setting, additional measures such as insulation, exhaust silencers, and low noise radiators necessary to reduce noise emissions. RICE generator sets such as the Wartsila 18V50SG, analyzed as a supply option in the 2019 IRP (TVA 2019a), are capable of operating at efficiencies of up to about 50 percent and heat rates of 8,266 BTU/KWh at summer full load. LPC-installed RICE generator sets are likely to be sited in industrial areas or adjacent to existing electrical substations. Suitable sites require access to a natural gas (or renewable gas) supply and a source of water for the generator set cooling system.

CHP systems, also known as cogeneration systems, produce electricity and thermal energy (heat) that is used for heating, cooling, steam generation for industrial processes, and other purposes. CHP systems are typically located at the point of consumption of the thermal energy, and the electricity may be utilized by the associated facility or fed into the local electrical grid. Because CHP systems recover thermal energy that would otherwise be wasted, they operate at high efficiencies of 60 to over 80 percent, significantly higher than stand-alone electrical generators and boilers that would otherwise provide the electricity and thermal energy (USDOE 2017). Emissions of air pollutants are also consequently lower. Most CHP systems operated by LPCs are expected to be fueled by natural gas, which drives a gas turbine or reciprocating engine attached to a generator and heat recovery unit. An alternative configuration would fuel a boiler or other industrial process with natural gas and use the rejected heat to generate electricity. This configuration is often used with solid fuels such as biomass and waste from the associated industrial process. RICE- and gas turbine-powered CHP systems can be configured to operate on landfill gas or digester gas. While the majority of U.S. CHP installations utilize reciprocating engines, gas turbine systems provide about two-thirds of U.S. CHP generating capacity (USDOE 2017).

CHP systems are best suited for applications with steady thermal and electrical loads. They are usually located at the site of the facility utilizing the thermal energy, which may be an industrial

plant, university campus, hospital, prison, or other facility (USDOE 2017). The electrical output of CHP systems installed under the Proposed Action Alternative is expected to be between 1 and 8 MW. Most of the electricity generated by the CHP system is typically used by the host facility with the remainder available to the local electrical grid. CHP systems are usually installed in a building and, as with stand-alone RICE generators, additional noise reduction measures may be necessary depending on the local setting.

TVA would not have approval authority over LPC generation resources that may be adopted under the Flexibility Proposal. Therefore, this EA addresses the potential impacts of the construction and operation of the flexible generation resources under the control of the LPCs in a generic non-site specific context and to the extent those impacts are foreseeable. It also addresses the impacts of the flexible generation resources on the overall environmental performance of the TVA power system.

The EA addresses the following general resource topics and includes a summary of relevant IRP EIS analysis by topic and analysis that addresses foreseeable LPC generation (given size restriction), to the extent practical:

- Energy Production and Use;
- Socioeconomics;
- Air Resources;
- Water Resources;
- Land Resources; and
- Waste Generation.

TVA notes that the effects of the proposed action on the physical environment depend on decisions made by entities outside of TVA's direct control. Because TVA cannot predict how or even when LPC decisions relating to generation would be made, the assessment of potential impacts on the physical environment involves some degree of speculation.

3.2 Energy Production and Use

This section describes an overview of TVA's current and projected future energy generation system, as described in the 2019 IRP and associated EIS (2019a), and the potential impacts to energy production and use that would be associated with the No Action and Proposed Action alternatives.

3.2.1 Affected Environment

3.2.1.1 Overview

TVA is the largest producer of public power in the U.S. and provides wholesale power to 154 LPCs and directly sells power to 58 industrial and federal customers. TVA's power system, with a generating capacity of approximately 38,000 MW, serves nearly 10 million people in a seven-state, 80,000-square-mile region (Figure 1). TVA's PSA includes most counties in Tennessee and portions of Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia. TVA's generating assets include: five coal-fired plants, three nuclear plants, 29 conventional hydroelectric plants, one pumped storage hydroelectric plant, nine natural gas combustion turbine (CT) gas plants, eight natural gas combined cycle (CC) gas plants, one diesel generator site, and 14 solar energy sites. In total, these assets constitute a portfolio of 33,500 MW. The remainder of delivered power is provided through long-term PPAs. TVA transmits electricity from these facilities over 16,000 circuit miles of transmission lines. Like other utility systems,

TVA has power interchange agreements with utilities surrounding its region and purchases and sells power on an economic basis almost daily (TVA 2019a).

Consumers of TVA-generated electricity consist of a mix of residential, commercial, and industrial end-use consumers (EUCs) in the PSA. Recent (2015-2018) energy sales totaled between 155,000 and 163,000 gigawatt-hours (GWh) annually, with sales in FY 2019 of approximately 163,000 GWh. Energy generation in FY 2019 is summarized in Figure 2.

The 2019 IRP found that in the current outlook scenario, future capacity requirements were similar to current requirements until the end of the 20-year planning horizon; at that time, required capacity was projected to increase slightly. However, the IRP reports that new generation resources will be needed to replace facilities that will be retired or power purchase agreements that will expire over the planning horizon.

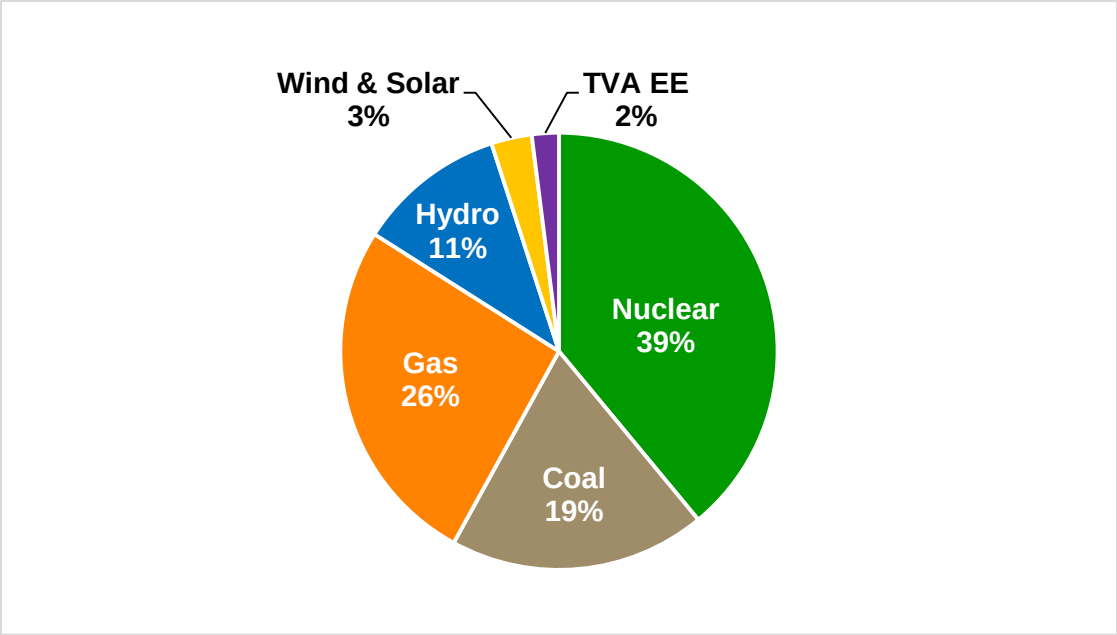

Figure 2. TVA FY 2019 Energy Generation

3.2.1.2 Renewable Energy in the TVA PSA

TVA's renewable energy generation in FY 2019 consisted of hydroelectric (11 percent), wind, and solar (a combined 3 percent; Figure 2). In FY 2019, TVA generated less energy from fossil fuels (45 percent) than the national average of 64 percent (USEIA 2019). As discussed in the 2019 IRP, TVA expects to increase the future generation of renewable energy, specifically utility-scale solar, while decreasing generation from fossil fuels.

3.2.2 Environmental Consequences

This section describes the potential impacts to energy production and use should the No Action or Proposed Action Alternative be implemented.

3.2.2.1 No Action Alternative

Under the No Action Alternative, TVA would continue to implement the LTP agreements but would not offer power supply flexibility options. Valley Partners would continue to rely on TVA

for their entire power requirements. Current and projected future energy generation would be as described in the 2019 IRP and associated EIS.

3.2.2.2 Proposed Action Alternative

Under the Proposed Action, TVA would establish Flexibility Agreements with Valley Partners to provide power supply flexibility with the Valley Partner LPCs providing up to approximately 800 MW of generation that would otherwise be provided by TVA. CHP generation, which is capable of providing continuous, baseload generation, would offset generation that would otherwise be provided by natural gas-fired combined cycle and coal-fired generators. Solar and RICE generating capacity provided by LPCs under the three deployment scenarios noted above during the early years of the 20-year IRP planning period would largely offset natural gas-fueled generation that would have been provided by TVA. During the later years of the IRP planning period, LPC solar and RICE generation would offset both TVA natural gas-fueled and solar generation. However, due to the relatively small proportion of TVA's overall generating capacity that would be provided by LPCs under the Proposed Action Alternative, and particularly LPC natural gas-fired generation, the Proposed Action Alternative is unlikely to markedly alter the TVA long-term power supply plan (TVA 2019a) or the timing of the construction of new generating capacity and retirement of existing generating capacity.

3.3 Socioeconomics

This section describes an overview of the existing socioeconomic conditions in the TVA PSA, as described in the 2019 IRP and associated EIS, and the potential impacts to socioeconomic conditions that would be associated with the No Action and Proposed Action alternatives.

3.3.1 Affected Environment

3.3.1.1 Overview

The estimated population of the TVA PSA was 10.3 million in July 2017, a 4.4 percent increase from July 2010. TVA projects that the rate of population increase in the TVA PSA will slow in the coming decades. Population density varies substantially among counties in the TVA PSA, which contains a mix of rural and metropolitan areas. The larger population concentrations tend to be located along major river corridors. Approximately 67.6 percent of the population of the TVA PSA lives in defined metropolitan statistical areas (MSAs). As of July 2017, there are four MSAs with populations over 500,000, all located in Tennessee: Nashville (1.9 million), Memphis (1.3 million), Knoxville (877,000), and Chattanooga (557,000). The largest metropolitan area in the TVA PSA located outside of Tennessee is Huntsville, AL, with a population of 455,000 as of July 2017 (TVA 2019a).

Under the TVA Act of 1933, as amended (the TVA Act), Congress charged TVA with advancing the social and economic welfare of the residents of the Tennessee Valley region. This is evidenced by low cost, reliable power benefitting industrial customers and economic growth, as well as the amount of capital investment in the TVA PSA. Capital investments include investments in the overall power system, such as funding for new and existing generating plants and general system improvements (TVA 2019a).

Selected social, demographic, and economic characteristics for the TVA PSA and the U.S. are presented in Table 2. Primary observations include:

- The population of the TVA PSA is slightly older and includes a higher proportion of persons self-identifying as "white alone" than in the U.S. as a whole;

- The economy of the TVA PSA has a slightly higher percentage of workers employed in "blue collar" occupations such as natural resources, construction, production, and transportation than the nation as a whole, and the proportion of persons with at least a high school degree is 84.7 percent, slightly lower than the national average; and
- The unemployment rate in the TVA PSA and the proportion of persons below the poverty level is higher than the national average, and per capita income is lower than the national average.

Table 2. Selected 2016 Social, Demographic, and Economic Characteristics

Characteristic	TVA PSA	U.S.
Median Age	40.8	37.7
Age 65 or Older	15.3%	14.5%
High School or Higher	84.7%	87.0%
Minority	26.3%	38.7%
Unemployment Rate*	7.7%	5.8%
Per capita income	$42,578	$51,640
Below Poverty Level	19.7%	12.7%
Employment in Management, Business, Science, and Arts Occupations	32.9%	37.0%
Employment in Service Occupations	16.8%	18.1%
Employment in Sales and Office Occupations	24.1%	23.8%
Employment in Natural Resources, Construction, and Maintenance	9.4%	8.9%
Employment in Production, Transportation, and Material Moving	16.8%	12.2%

Source: TVA 2019a

*The TVA PSA and U.S. unemployment rates have declined since 2016

3.3.1.2 Minority and Low-Income Populations

Environmental justice-related impacts are analyzed in accordance with Executive Order (EO) 12898 to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority and low-income populations. While not subject to this EO, TVA routinely considers environmental justice in its NEPA review processes.

The 2019 IRP EIS presents recent information about the geographical distribution of low-income and minority populations within the TVA PSA. Because the alternatives considered herein would apply throughout the TVA PSA, this EA summarizes region-wide information. As indicated in Chapter 4 of the 2019 IRP EIS, minority populations comprise a lower proportion of the total regional population than that of the U.S. population. The proportion of the regional population that is below poverty level (i.e., low-income) is higher than the national proportion. Refer to TVA (2019a) for more detailed information.

This EA also incorporates by reference TVA's 2018 Wholesale Rate Change EA, which discusses energy use and the proportion of income spent on energy in the context of low-income and minority populations. The 2018 Wholesale Rate Change EA discusses that, in general, low-income households tend to use less energy than higher-income households but spend a higher proportion of their incomes on energy bills. Also within the TVA PSA, minority households are more likely to be low-income households than non-minority households (TVA 2018).

3.3.2 Environmental Consequences

This section describes the potential impacts to socioeconomic resources should the No Action or Proposed Action Alternative be implemented.

3.3.2.1 No Action Alternative

Under the No Action Alternative, TVA would continue to implement the LTP agreements but would not offer power supply flexibility options. Valley Partners would continue to rely on TVA for their entire power requirements. Valley Partners would not be able to reduce costs to larger customers or address customer demands for an electrical supply with lower or no carbon emissions. Additionally, some LPCs would not be able to manage their own costs through the reduction of monthly peak demand and, by extension, their wholesale power bill.

3.3.2.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would establish Flexibility Agreements with Valley Partners to provide power supply flexibility. The five percent cap (and system-wide total cap of 800 MW) on energy generated by participating LPCs was selected by TVA, in part, because it would have little effect on TVA costs and the rates paid by TVA customers. The deployment scenarios utilized by the participating LPCs are likely to vary according to their customer demands. Subscriber-based community solar programs, a likely component of all three deployment scenarios, would have little to no effect on the energy bills of non-participating LPC customers and would have minimal socioeconomic impacts. Most residential community solar subscribers would likely be middle- to higher income households, as the required initial investment would deter many low-income households.

The cost of CHP generation under Deployment Scenarios 2 (90 percent solar and 10 percent natural gas) and 3 (50 percent solar and 50 percent natural gas) would largely be borne by the industrial, commercial, or institutional facility receiving the thermal energy and the LPC and would have little to no effect on the energy bills of other LPC customers. The CHP generation would have beneficial economic impacts to the host facility through the long-term reduction in the cost of producing the thermal energy necessary for operating the facility.

The costs of constructing and operating stand-alone natural gas-fired generation under Scenarios 2 and 3 would likely be borne by all of the LPC's customers. Over time, there could be minor cost savings to the LPC and its customers if the LPC's stand-alone gas-fired generation displaces higher cost TVA generation, particularly during times of peak energy demand.

The Proposed Action is not expected to result in any adverse economic impacts and would likely have small beneficial impacts to the customers of participating LPCs. The construction of the generating facilities by participating LPCs would result in minor, localized, short-term increases in employment and the associated purchase of goods and services. Increases in employment for the operation of the generating facilities would be negligible.

The construction and operation of solar generation facilities is unlikely to result in any disproportionate impacts to minority and low-income populations. The construction and operation of natural gas-fired generation facilities could adversely affect minority and low-income populations, primarily from noise during facility operation. Compliance with local zoning ordinances and local and Occupational Health and Safety Administration noise standards would reduce this potential.

3.4 Air Resources

This section describes an overview of the existing air quality and greenhouse gas (GHG) emissions in the TVA PSA, as described in the 2019 IRP and associated EIS, and the potential impacts on air quality and GHG emissions that would be associated with the No Action and Proposed Action alternatives.

3.4.1 Affected Environment

Ambient air quality is determined by the type and concentration of pollutants emitted into the atmosphere, the size and topography of the air shed in question, and the prevailing meteorological conditions in that air shed. Through its passage of the Clean Air Act (CAA) of 1970 and its amendments, Congress mandated the protection and enhancement of our nation's air quality. The U.S. Environmental Protection Agency (USEPA) established the National Ambient Air Quality Standards (NAAQS) for the following criteria pollutants to protect the public health and welfare: sulfur dioxide (SO_2), ozone (O_3), nitrogen dioxide, particulate matter whose particles are less than or equal to 10 micrometers (PM_{10}), particulate matter whose particles are less than or equal to 2.5 micrometers ($PM_{2.5}$), carbon monoxide (CO), and lead. These NAAQS reflect the relationship between pollutant concentrations and health and welfare effects. Areas not meeting the standards are called "nonattainment" areas. There are no nonattainment areas designated within the TVA PSA.

TVA coal-fired and natural gas-fired electric generating facilities either directly emit these pollutants or contribute to their formation (O_3 and $PM_{2.5}$) in certain atmospheric conditions. Generally, TVA's hydroelectric, nuclear, and renewable energy facilities do not directly contribute to air emissions. TVA has installed air emission controls at its fossil-fueled facilities to reduce air emissions. These emission controls include flue gas desulfurization ("scrubbers"), selective catalytic and non-catalytic nitrogen oxide (NO_x) reduction systems, and particulate control systems (TVA 2019a).

Hazardous air pollutants (HAPs) are those that are listed under Section 112(b) of the CAA because they present a threat of adverse human health effects or adverse environmental effects. The CAA requires the USEPA to regulate HAPs from listed categories of industrial facilities. HAPs are toxic air pollutants, which are known or suspected to cause cancer or other serious health effects or adverse environmental conditions. The CAA identifies 187 pollutants as HAPs. Most HAPs are emitted by human activity, including motor vehicles, factories, refineries, and power plants. Mercury is the HAP compound most associated with the burning of coal and power plant emissions. Other important issues concerning power plant emissions include acid deposition related to SO_2 and NO_x emissions and visibility impairment, which, in the TVA region, is related mostly to ammonium sulfate particles formed from SO_2 emissions from coal-fired power plants. The most sensitive areas in the region are high elevation, forested areas such as the Great Smoky Mountains National Park (TVA 2019a). The nature of these pollutants, their effects, and their relationships to power production and industry are discussed more fully in the 2019 IRP EIS (TVA 2019a).

Greenhouse gases (GHGs) occur in the atmosphere both naturally and as a result of human activities, such as the burning of fossil fuels. GHG emissions due to human activity are the primary cause of increased atmospheric concentration of GHGs since the industrial age and are the primary contributor to climate change. The primary GHGs are carbon dioxide (CO_2), methane, and nitrous oxide. GHGs are non-toxic and non-hazardous at normal ambient concentrations, and there are no applicable ambient air quality standards or emission limits for GHGs under the CAA. The primary greenhouse gas emitted by electric utilities is CO_2, produced by the combustion of coal, natural gas, and other fossil fuels. Under the 2019 IRP, TVA CO_2 emissions (measured by both tons emitted and by the emissions rate) resulting from the power generated by TVA and from non-TVA facilities marketed by TVA are anticipated to continue to decline (TVA 2019a). This decline is due to reduced coal-fired generation, increased natural gas-fired generation, and increased renewable generation.

3.4.2 Environmental Consequences

This section describes the potential impacts to climate and air quality should the No Action or Proposed Action Alternative be implemented.

3.4.2.1 No Action Alternative

Under the No Action Alternative, TVA would continue to implement the LTP agreements and current trends in air quality would continue. Emissions of criteria air pollutants and GHGs, from stationary emission sources, especially in the power sector, and from mobile sources, would continue to decline in the TVA region. These declines are expected due to market forces (e.g., low prices for natural gas), demands for more renewable energy, and the effects of USEPA requirements for new mobile source engine emissions and cleaner fuels.

3.4.2.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would establish Flexibility Agreements with Valley Partners to provide power supply flexibility. Any generating facilities developed by LPCs under the Proposed Action would be required to comply with the applicable regulations of the Clean Air Act. Construction activities would result in emissions of air pollutants from the operation of fossil-fueled construction equipment. These would be short-term and would not result in adverse impacts to air quality. Construction activities could also result in the emission of particulates by site preparation activities. These would be localized in the project areas and minimized by the use of applicable best management practices. Natural gas-fired generation emits NOx, CO, and CO_2. Emissions of SO_2 and mercury are negligible. The extraction and transport of natural gas also emits methane, a potent GHG (TVA 2019a).

3.4.2.2.1 Deployment Scenario 1: 100 Percent Solar Generation

Solar generation does not produce emissions of air pollutants, including GHGs, and the solar generation installed under this and the other deployment scenarios would mostly offset natural gas-fired generation. In comparison to the ongoing emissions decline in the region as described for the No Action Alternative, Deployment Scenario 1 is expected to provide slightly faster emissions decline in the region. The effect would be modest, given the replacement solar power would displace five percent or less of TVA's existing generating capacity and, due to the low capacity factor of solar generation, a smaller proportion of TVA generation. Because most of the displaced TVA generation would be natural gas-fueled, Deployment Scenario 1 would result in small reductions in emissions of NOx and CO_2, air pollutants emitted by natural gas-fired generation. The reductions in air pollutants, including CO_2, would likely be within the range predicted for the 2019 IRP under the Current Outlook Scenario (TVA 2019a). Overall impacts to air resources would be small and beneficial.

3.4.2.2.2 Deployment Scenario 2: 90 Percent Solar and 10 Percent Natural Gas-Fired Generation

The impacts to air resources under this deployment scenario would be similar to and slightly greater than those of Deployment Scenario 1 due to the small proportion of natural gas-fired generation. The included gas generation has relatively low emissions compared to some TVA natural gas-fired generators, and the thermal energy processes in CHP systems further reduce emissions. Overall impacts to air resources of Deployment Scenario 2 would be small and beneficial. Emissions from the TVA power system would be in the range forecast in the 2019 IRP.

3.4.2.2.3 Deployment Scenario 3: 50 Percent Solar and 50 Percent Natural Gas-Fired Generation

With the larger proportion of natural gas-fired generation, Deployment Scenario 3 would result in greater emissions of air pollutants, including CO_2, than the other deployment scenarios. As with Deployment Scenario 2, the included gas generation has relatively low emissions compared to some TVA natural gas-fired generators, and the thermal energy processes in CHP systems further reduce emissions. Overall impacts to air resources would be small and beneficial, and emissions from the TVA power system would be in the range forecast in the 2019 IRP.

3.5 Water Resources

This section presents an overview of existing water resources in the TVA PSA, as described in the 2019 IRP EIS, and the potential impacts on these water resources that would be associated with the No Action and Proposed Action alternatives. Components of water resources that are analyzed include groundwater, surface water, wetlands, and floodplains.

3.5.1 Affected Environment

The quality of the region's surface water and groundwater is critical to the protection of human health and aquatic life. Major watersheds in the TVA region include the entire Tennessee River basin, most of the Cumberland River basin, and portions of the lower Ohio, lower Mississippi, Green, Pearl, Mobile-Tombigbee, and Alabama River basins. As described in detail in the 2019 IRP EIS, these water resources provide habitat for aquatic life, including ecologically and recreationally important invertebrate and fish communities; recreational opportunities; domestic and industrial water supplies; navigation; and other benefits (TVA 2019a). Wastewater discharges from cities or industries and runoff from nonpoint source activities such as construction, agriculture, mining, and air deposition can potentially degrade water quality.

Pollution involves the presence or introduction of a substance or object into water resources that may harm the water resource and impact its beneficial uses, such as swimming or aquatic life. Every two years, states are required to update and submit a report to the USEPA under Section 303(d) of the Clean Water Act (CWA). This report identifies the impaired lakes and streams that are not complying with water quality criteria and, consequently, are not suitable for their designated use(s). Thus, each state's 303(d) report provides an updated overview of assessed water quality in each state.

Sources of degraded water quality may include:

- Wastewater discharges from municipal sewage treatment systems, industrial facilities, concentrated animal feeding operations, and other sources;
- Runoff discharges from agriculture, forest management activities, urban uses, and mine lands, which transport sediment and other pollutants into streams and reservoirs. Runoff from commercial and industrial facilities and some construction sites is regulated through

state National Pollutant Discharge Elimination System (NPDES) stormwater permitting programs. Sources not regulated through the NPDES program are referred to as "nonpoint source" runoff;

- Cooling systems, such as those used by electrical generating plants and other industrial facilities to withdraw water from streams or reservoirs, use it to cool facility operations, and then discharge the above ambient water into streams and reservoirs. Impacts can result from temperature changes, the trapping of organisms against intake screens, or sucking organisms through the facility cooling system. These water intakes and discharges are controlled through state-issued NPDES permits;
- Air pollution in the form of airborne pollutants such as SO_2, mercury, and NO_x being spread through rainfall and deposition;
- Man-made impoundments such as dams can cause low dissolved oxygen and other water quality issues in head and tail waters; and
- Contamination of the bottom sediments of a stream from point or non-point source pollution can cause bioaccumulation of contaminant in fish tissue, which could lead to fish consumption advisories and compromise of species health, especially of bottom feeding/dwelling species.

Additional regulatory protections for water quality and the mechanisms of how power generation can affect water quality and aquatic life are discussed in detail in the 2019 IRP EIS (TVA 2019a).

Groundwater refers to water located beneath the surface in rock formations known as aquifers. Eight major aquifers occur in the TVA region. Approximately half of the region has limited groundwater availability because of natural geo-hydrological conditions. More than 64 percent of the region's residents rely totally, or in part, on groundwater for drinking water. More than 1.7 million residents (22 percent) in the region maintain individual household groundwater systems, usually a well. All areas in the Tennessee Valley region can generally supply enough water for at least domestic needs. For the most part, the groundwater quality is adequate to support existing water supply uses even though some minimal treatment, such as filtration and chlorination, is sometimes required. Generating facilities involving combined cycle combustion turbines often make use of groundwater for either cooling or reinjection of heated water (TVA 2019a).

Wetlands are areas that are inundated or saturated by water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Wetlands occur across the TVA region and are most extensive in the south and west where they comprise 5 percent or more of the landscape (U.S. Geological Survey 2016). Wetlands in the TVA region consist of two main systems: palustrine wetlands such as marshes, swamps and bottomland forests dominated by trees, shrubs, and persistent emergent vegetation, and lacustrine wetlands associated with lakes such as aquatic bed wetlands (Cowardin et al. 1979). Riverine wetlands associated with moving water within a stream channel are also present but relatively uncommon. Almost 200,000 acres of wetlands are associated with the TVA reservoir system, where they are more prevalent on mainstem reservoirs and tailwaters than tributary reservoirs and tailwaters (TVA 2004). Almost half of this area is forested wetlands; other types include aquatic beds and flats, ponds, scrub/shrub wetlands and emergent wetlands (TVA 2019a).

Floodplains are the relatively level land areas along a stream or river that are subjected to periodic flooding. The area subject to a one-percent chance of flooding in any given year is

normally called the 100-year floodplain. The area subject to a 0.2-percent-chance of flooding in any given year is normally called the 500-year floodplain. It is necessary to evaluate development in the 100-year floodplain to ensure that the project is consistent with the requirements of EO 11988 – Floodplain Management. In the TVA region, floodplains are associated with reservoirs, streams, ponds, and sinkholes. Power generation facilities of any type, as well as electric transmission lines, could be proposed by TVA or outside entities anywhere in the TVA region (TVA 2019a).

3.5.2 Environmental Consequences

This section describes the potential impacts to water resources should the No Action or Proposed Action Alternative be implemented.

3.5.2.1 No Action Alternative

Under the No Action Alternative, TVA would continue to implement the LTP agreements and the current condition of water quality in the TVA PSA would be unaffected.

3.5.2.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would establish Flexibility Agreements with Valley Partners to provide power supply flexibility. Potential impacts to water resources from generating capacity installed by LPCs are regulated by the Clean Water Act, including the NPDES permitting system, which regulates discharges of water pollutants, and CWA Section 404, which regulates the discharge of dredge and fill material in streams and wetlands. The seven states in the TVA PSA have also enacted laws regulating water quality and implementing the CWA. As part of this implementation, the states classify water bodies according to their uses and establish water quality criteria specific to these uses. Each state has also issued an antidegradation statement containing specific conditions for regulated actions and designed to maintain and protect current uses and water quality conditions. Some TVA-region states provide additional protections for streams and wetlands. Developments in floodplains must be regulated for communities that participate in the Federal Emergency Management Agency National Flood Insurance Program (NFIP), and a large proportion of communities in the TVA PSA participate in this program. In addition, development across, along, or in the Tennessee River and its tributaries is also subject to the requirements of Section 26a of the TVA Act. Activities proposed within Section 26a jurisdiction and/or in places where TVA owns property or property rights would be subject to review under EO 11988 in connection with TVA's Section 26a or land use approvals, or both.

3.5.2.2.1 Deployment Scenario 1: 100 Percent Solar Generation

Solar generation in the TVA region typically does not require water to operate and does not discharge wastewater (TVA 2019a). Under this scenario, the solar generation would most likely displace TVA natural gas-fired generation as well as, during the latter years of the planning period, some TVA solar generation. The displaced natural gas-fired generation would include generation from combined cycle units, which require about 250 gallons/MWh of water to operate (TVA 2019a) and combustion turbines, which require much smaller quantities of water to operate. Most of this water is for cooling and is evaporated. Any system-wide change in water usage and wastewater discharges would be negligible.

Generally, sites within or containing wetland areas tend to be unsuitable for construction of solar projects due to the presence of water. Any wetland impacts would be mitigated under regulations implementing Section 404 of the CWA, applicable state regulations, and EO 11990 – Protection of Wetlands. Generally, the development of ground-mounted or rooftop-mounted solar facilities can result in impacts to floodplains. If a solar facility is located within the 100-year

floodplain, then PV panels and all electrical equipment would necessarily be located at least 1 foot above the 100-year flood elevation at that location, and the project would have to comply with the requirements of the NFIP consistent with the local community's floodplain regulations. If the project is located along a TVA reservoir, more stringent flood risk requirements may apply. If the proposed solar facility involves mounting the equipment on an existing rooftop, an evaluation of flooding impacts to the building would be considered. Although the PV equipment would be located on top of a building, at an elevation that would likely be well above the 100-year flood elevation, the building itself could be subject to flood damage. Typically, the equipment at proposed solar sites would be located at elevations above the 100-year floodplain and PV panels and all electrical equipment would be elevated consistent with the requirements of the NFIP. Compliance with applicable laws and regulations would minimize many of the potential impacts to wetlands and floodplains.

3.5.2.2.2 Deployment Scenario 2: 90 Percent Solar and 10 Percent Natural Gas-Fired Generation

Under this scenario, the effects of the solar generation on water resources would be similar to those of Deployment Scenario 1. Operation of the relatively small proportion (total of 80 MW) of natural gas-fired facilities would require small quantities of water, primarily for cooling purposes and would produce little to no wastewater. The Wartsila 18V50SG RICE generator set, for example, requires about 0.05 gallons/MWh. RICE generator sets used in CHP systems would have similar water requirements, and turbine generators used in CHP systems often require no water to operate. The thermal energy side of a CHP system uses water to produce steam or for other purposes. This often does not result in a net increase in water consumption or wastewater discharge by the host facility. Because the natural gas-fired generation developed under this scenario would primarily displace TVA natural gas-fired generation, overall effects on water resources would be negligible. As with Deployment Scenario 1, compliance with applicable laws and regulations would minimize many of the potential impacts to water resources.

3.5.2.2.3 Deployment Scenario 3: 50 Percent Solar and 50 Percent Natural Gas-Fired Generation

Compared to the other deployment scenarios, this scenario would have the greatest impact on water resources due to the use of water by the natural gas-fired stand-alone RICE generator sets and CHP systems. The water use rates by these systems is low compared to the water use by the TVA natural gas-fired generation that they would displace, resulting in a small net decrease in water use by the TVA power system. Changes in wastewater discharges would be negligible. As with the other deployment scenarios, compliance with applicable laws and regulations would minimize many of the potential impacts to water resources.

3.6 Land Resources

This section describes an overview of existing land resources in the TVA PSA, as described in the 2019 IRP and associated EIS, and potential impacts to land resources associated with the No Action and Proposed Action alternatives.

3.6.1 Affected Environment

TVA's power system serves nearly 10 million people in a seven-state, 80,000-square-mile region. Major land uses in the TVA region include forestry, agriculture, and urban/suburban/industrial development (USDA 2018). Regional land use is described in detail in the 2019 IRP EIS (TVA 2019a). Of the non-federal land area, approximately 12 percent is classified as developed and 88 percent as rural (USDA 2013). About 28 percent of the rural area is classified as farmland and 60 percent is classified as forestland. Trends in recent decades show an increase in developed land, mostly through conversion of farmland. Lands in

the TVA region support diverse plant and animal populations, including many economically and recreationally important species and species classified as endangered or threatened. Refer to TVA (2019a) for more detailed information.

3.6.2 Environmental Consequences

This section describes the potential impacts to land resources should the No Action or Proposed Action Alternative be implemented. Several Federal, state, and local laws and regulations affecting land resources are applicable to LPC generating facilities. These include the Federal Endangered Species Act, which prohibits actions which would adversely affect plant and animal species listed as endangered or threatened under the act. State and local regulations protect many designated historic sites and districts, as well as cemeteries. Many communities, particularly in more urban areas, have also adopted zoning ordinances, which prescribe allowable uses of land areas within the community's jurisdiction. A large proportion of the more rural parts of the TVA PSA have no zoning restrictions.

3.6.2.1 No Action Alternative

Under the No Action Alternative, TVA would continue to implement the LTP agreements and there would be no impacts to land resources from the construction and operation of LPC generating facilities under Flexibility. Regional land use trends and development in the TVA PSA would continue as identified in the 2019 IRP EIS (TVA 2019a).

3.6.2.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would establish Flexibility Agreements with Valley Partners to provide power supply flexibility.

3.6.2.2.1 Deployment Scenario 1: 100 Percent Solar Generation

The construction and operation of up to 800 MW of solar generation by participating LPCs would require up to about 6,900 acres of land, assuming the arrays were all ground-mounted, single-axis tracking systems. This represents between about 12 and 20 percent of the land area, mostly for solar, required to implement the 2019 IRP under the Current Outlook Scenario (TVA 2019a) and would likely offset a portion of the forecast IRP land requirement. Other solar configurations, particularly rooftop-mounted solar, would reduce this land area.

Much of the required land area would likely be relatively flat farmland which is distributed across the TVA PSA. As described in the 2019 IRP EIS (TVA 2019a), the development of solar facilities on farmland often removes the area from agricultural production but does not result in long-term impacts that prevent its future use for farming. The availability of relatively flat land suitable for solar development, however, may be limited within the more urban territories of some of the largest LPCs.

Generally, the development of ground-mounted solar facilities can result in the clearing of forests, alteration of habitats for plants and animals, potentially including endangered and threatened species, and impacts to archaeological sites and historic areas, and scenic landscapes (TVA 2019a). Solar facilities have a low profile but, depending on the terrain and other site characteristics, can alter local scenery. Compliance with applicable laws and regulations would minimize many of these potential impacts.

3.6.2.2.2 Deployment Scenario 2: 90 Percent Solar and 10 Percent Natural Gas-Fired Generation

The solar generation in this deployment scenario would occupy up to about 6,200 acres. The potential 80 MW of natural gas-fired generation would occupy a much smaller land area than

the equivalent capacity of ground-mounted solar generation. Individual gas-fired generators and CHP systems require small land areas, often less than an acre, and all CHP systems would be sited on industrial, commercial, or institutional campuses. As with Deployment Scenario 1, compliance with applicable laws and regulations would minimize many of the potential impacts to land resources. Overall impacts to land resources under this deployment scenario would likely be insignificant and within the range of those of the 2019 IRP (TVA 2019a).

3.6.2.2.3 Deployment Scenario 3: 50 Percent Solar and 50 Percent Natural Gas-Fired Generation

The solar generation in this deployment scenario would occupy up to about 3,440 acres and the gas-fired generation would occupy a much smaller land area. Individual gas-fired generators and CHP systems require small land areas, often less than an acre, and all CHP systems would be sited on industrial, commercial, or institutional campuses. This deployment scenario has the lowest land requirements and potentially the lowest likelihood of adverse impacts to land resources. As with the other deployment scenarios, compliance with applicable laws and regulations would minimize many of the potential impacts to land resources. Overall impacts to land resources under this deployment scenario would likely be insignificant and within the range of those of the 2019 IRP (TVA 2019a).

3.7 Waste Generation

This section describes an overview of existing waste management within the TVA PSA, as described in the 2019 IRP EIS, and the potential impacts to waste management that would be associated with the No Action and Proposed Action alternatives. Components of waste management that are analyzed include solid and hazardous waste and materials.

3.7.1 Affected Environment

3.7.1.1 Residential, Commercial, and Industrial Wastes

Residential and commercial wastes are usually generated in many diffusely located areas and handled at municipal solid waste landfills. Most municipalities and counties currently engage in long-range planning processes to ensure that adequate capacity is provided for solid wastes generated within their jurisdictions. Solid waste reduction and recycling is an important emphasis in most of these plans. For example, in 2017, Tennessee businesses, industries, citizens, and others disposed of 17,045,462 tons of solid waste. Of this amount, 7,373,749 tons went to Class 1 landfills and 161,897 tons were recycled, reused, or diverted to other facilities (TDEC 2018).

Current legislative and regulatory programs encourage and/or mandate the reduction, recycling, and proper disposal of industrial solid and hazardous wastes. The states within the TVA PSA have state-administered Resource Conservation and Recovery Act (RCRA) equivalent programs, which emphasize waste reduction, recycling, and proper handling and disposal of solid and hazardous wastes. Industries benefit both financially and from a public relations standpoint by engaging in waste reduction and recycling opportunities in the same way that TVA benefits from its marketing and utilization of coal combustion residuals (CCR) that are a by-product of coal-based generation. It is, therefore, likely that industrial solid and hazardous waste generation and disposal will continue to decline in the future.

Disposal of solar equipment at the end of its useful life could also result in solid and hazardous waste. Solar panels can be recycled, but recycling is currently not widely available in the U.S. (Marsh 2018). However, options for recycling solar panels are expected to increase as the overall market expands and currently deployed panels near the end of their expected lives. If

recycling is not available, solar panels often end up in landfills. Recycling of typical solar PV panels lacked strong economic rationale from 2010 to 2015 (Tao and Yu 2015).

The impacts of solar equipment disposal, especially improper disposal, have been widely noted in various studies (e.g., Aman et al. 2015; Paiano 2015). A detailed report on global waste from solar systems estimated that the U.S. will generate a cumulative 7.5 million to 10 million tons of solar equipment waste by 2050, making the U.S. the second greatest producer of solar waste after China. That report also estimated that by 2050, global annual waste from solar panels alone could exceed 10 percent of the total global electronic waste produced in recent years (Weckend et al. 2016).

Additionally, only the European Union has enacted waste regulations specific to solar panels. In other countries, including the U.S., solar panels are typically treated as general waste or industrial waste. The most common type of solar panels produced globally are based on crystalline silicon technology. These panels are composed primarily of glass, aluminum, silicon, polymer, and copper (Weckend et al. 2016).

An alternative solar panel technology that is currently less common is termed thin-film cadmium telluride, which is composed primarily of glass and polymer (Weckend et al. 2016). In addition, these panels contain small amounts of cadmium compounds, which are potentially harmful to human health if leached from landfills. The potential human health burden from these panels in landfills was assessed, and it was determined that they did not likely present a material risk given current levels of solar adoption (Cyrs et al. 2014).

Additional sources of waste related to solar systems include panel mounting and racking systems, which are typically composed of aluminum and steel. A smaller total quantity of waste may also be produced from end-of-life electrical inverters and stationary batteries.

3.7.1.2 TVA-Generated Wastes

Types of wastes typically produced by construction activities, whether by TVA or others, include vegetation, demolition debris, oily debris, packing materials, scrap lumber, and domestic wastes or garbage. Non-hazardous wastes (excluding CCR) typically produced by common operation of TVA facilities include sludge and demineralizers from water treatment plant operations, personal protective equipment, oils and lubricants, spent resins, desiccants, batteries, and domestic waste. In 2016, TVA facilities produced approximately 23,000 tons of non-hazardous solid waste per year; this quantity decreased to approximately 18,750 tons in 2017 (TVA 2019a).

TVA facilities include large, small, and very small quantity generators (previously conditionally exempt generators) of hazardous waste. Hazardous non-radiological wastes typically produced by common TVA facility operations include paint and paint solvents, paint thinners, discarded out-of-date chemicals, parts washer liquids, sand blast grit, chemical waste from cleaning operations, and broken fluorescent bulbs. Routine operations between 2015 and 2017 created an average of 9.49 tons of hazardous waste. In 2017, approximately 27.4 tons of universal waste was generated and recycled by TVA (TVA 2019a). TVA's hazardous wastes, those requiring special handling under the Toxic Substances Control Act (TSCA), and universal waste are generally shipped to Waste Management's Emelle, Alabama facility for disposal (TVA 2019a).

Coal combustion solid wastes or residues (i.e. CCRs) include fly ash, bottom ash, boiler slag, char spent bed material, and sludge from operation of wet flue gas desulfurization systems. In the past, the USEPA determined that CCRs are not hazardous, and in April 2015 the USEPA

decided to continue to regulate them as non-hazardous, solid waste. In 2015, TVA produced approximately 3.9 million tons of CCRs, of which 33.6 percent was utilized or marketed (TVA 2016). Annually, CCR production at TVA's coal-fired plants fluctuates due to a variety of factors including: plant planned and forced maintenance outages, load swings, plant dispatch (the process by which plants are directed to increase or decrease power generation based on the cost of production at each plant (generally the larger, more efficient units run more and the smaller, less efficient units run less)), and variation in fuel supplies. Additionally, recent decisions to retire coal-fired generation further reduce the amount of CCRs generated by TVA at its plants. The amount of CCRs that are disposed of is also reduced through marketing and utilization of these by-products in a number of commercial applications including the use of fly ash in concrete products, bottom ash as aggregate in cement block manufacturing, boiler slag for roofing granules and industrial abrasives, and scrubber gypsum in gypsum wallboard and cement manufacturing.

3.7.2 Environmental Consequences

This section describes the potential impacts to waste management should the No Action or Proposed Action Alternative be implemented. Waste management is subject to several Federal laws and associated regulations, including the Comprehensive Environmental Response, Compensation, and Liability Act, the Resource Conservation and Recovery Act, TSCA, and various state laws and regulation.

3.7.2.1 No Action Alternative

Under the No Action Alternative, TVA would continue to implement the LTP agreements and current trends in waste production and reduction, as identified in the example for Tennessee above and in the 2019 IRP, would continue in the TVA PSA.

3.7.2.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would establish Flexibility Agreements with Valley Partners to provide power supply flexibility. The construction of LPC generating facilities under all of the deployment scenarios produces various non-hazardous solid wastes, including relatively large quantities of packaging materials for solar facilities. These wastes would be recycled where feasible, and remaining wastes would be managed in accordance with applicable laws and regulations. Any hazardous wastes generated during construction would also be managed in accordance with applicable laws and regulations.

Wastes would be generated during the operation of the solar and natural gas-fired generating facilities, including lubricants, hydraulic fluids, and replacement parts, including batteries. These wastes would be recycled where feasible and otherwise managed in accordance with applicable laws and regulations.

The LPC generation would largely offset TVA natural gas-fired generation, which produces relatively small quantities of wastes (IRP EIS Section 4.7, TVA 2019a). The quantities of CCR produced by TVA coal-fired generation are unlikely to be affected. Overall quantities of wastes from the TVA power system, and their associated impacts, would be similar under all of the Proposed Action deployment scenarios.

3.8 Cumulative Impacts

Cumulative impacts are defined as the effects of the Proposed Action when considered together with other past, present, and reasonably foreseeable future actions. This section addresses the cumulative impacts of the Project and any reasonably foreseeable actions in the vicinity.

TVA utilizes its IRP process to consider the many cumulative market and social forces that programs addressing renewable energy resources, expansion of DER, energy efficiency, and other relevant inputs, have on TVA's energy generation. TVA also utilizes its IRP process to provide direction on how to best meet future electricity demand. The 2019 IRP provides an important discussion regarding past, present, and foreseeable activities that influence energy use, and the associated EIS describes cumulative impacts from combining different scenarios and strategies (TVA 2019a).

Other related TVA activities that may cumulatively affect resources of concern are the Green Power Providers, Green Power Switch and Green Invest programs, economic development efforts, rate changes, and energy efficiency programs for residences, businesses, and industries (e.g., TVA EnergyRight programs).

The Green Power Providers program is an EUC generation dual metering program that began in 2003 as the Generation Partners Pilot Program. It was developed in an effort to provide LPCs the opportunity to support environmental stewardship while responding to the growing consumer interest in generating renewable power. It also provided customers with an alternative to net metering that was compatible with the existing power contracts between TVA and LPCs. Participation in the program is optional for LPCs. Through the program, participating LPCs' residential and commercial EUCs with renewable solar, wind, low-impact hydro, or biomass generating facilities, subject to capacity limits, sell all of the generation to TVA for the term of their 20-year Participation Agreement for a fixed kilowatt-hour rate (TVA 2019b). The Green Power Providers program was closed to new applicants in early 2020. Because the generation from this program represents such a small portion of overall generation in the TVA PSA, the program does not result in discernable effects on the environment (TVA 2019b).

The Green Power Switch program allows those interested in supporting renewable energy to purchase blocks of renewable energy backed by Renewable Energy Certificates (RECs) and therefore increase the percentage of electricity used that is generated by renewable resources. This program is available to all LPCs and their customers, and will become more accessible in 2020 as the block size is increased and price is decreased.

TVA's Green Invest program also promotes DER development in the Tennessee Valley. The program is intended to serve a wide range of customers seeking access to large-scale renewable energy. The Green Invest framework is modeled on TVA's work that began in 2018 to meet the renewable energy needs of Facebook and Google data centers locating in the region. The program is now available to customers across TVA's service territory including universities, manufacturing, and LPCs. Green Invest meets the growing demand for green power through agreements to build new, large-scale renewable energy installations through a competitive bid process. While available to all LPCs, Valley Partners generally receive commercial terms reflective of the long-term commitment they have made to the Valley, resulting in more favorable solutions for their customers. In 2019, several Green Invest projects have been initiated with 662 MW of renewable generation planned. All projects contracted in 2019 are solar facilities and would have similar impacts as those described in the 2019 IRP EIS and in this EA.

In 2018, TVA implemented a rate change that included establishing a grid access charge[2]. In reviewing the rate change proposal, TVA found that the grid access charge may marginally

[2] The Grid Access Charge is a 0.5 cent/kWh wholesale charge based on an LPC's prior five years of energy sales. It was offset by a 0.5 cent/kWh reduction in ongoing energy charges.

affect the incentive for end users to invest in alternative energy sources. TVA estimated, for instance, that the payback period of a typical rooftop solar investment would increase from approximately 15 to 16 years. Other than minor socioeconomic impacts, TVA found that the 2018 rate change may result in negligible changes in energy sales that are not substantial enough to discern impacts to environmental resources.

Climate change resulting from GHG emissions is a cumulative impact. TVA assessed GHG emissions, under the worst-case scenario, in the air resources section (Section 3.4) as a proxy for potential climate change impacts. The analysis of the direct and indirect effects for GHG emissions adequately addresses the cumulative impacts for climate change because the potential effects of GHG emissions are inherently a global cumulative effect.

The overall cumulative impacts of implementing the Proposed Action Alternative and the associated construction and operation of distributed energy resources by participating LPCs are expected to be minimal and within the bounds of the impacts described in the 2019 IRP EIS (TVA 2019a).

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CHAPTER 5 – REFERENCES

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