2019 IRP and EIS Frequently Asked Questions

Updated August 22, 2019

Sections

1 — TVA Board of Directors Approves 2019 Integrated Resource Plan (IRP) Recommendation

When did the TVA Board of Directors approve the 2019 Integrated Resource Plan (IRP) Recommendation?
The Board approved the 2019 IRP Recommendation on August 22, 2019, at its Knoxville, Tenn., meeting.

What happens next?
TVA will prepare a Record of Decision, which is expected to be completed in September 2019. After the Record of Decision is published, the 2019 IRP will replace the 2015 IRP that TVA currently uses as its guide for resource planning.

What is the IRP?
TVA's 2019 IRP is a long-term plan that provides direction on how TVA can best meet future demand for power. It shapes how we will continue to provide low-cost, reliable, clean electricity; support environmental stewardship; and foster economic development in the Tennessee Valley for the next 20 years.

What is the Environmental Impact Statement (EIS)?
Per the National Environmental Policy Act (NEPA), TVA prepared an EIS to analyze the 2019 IRP's potential impacts on the environment, economy and population in the Tennessee Valley.

When did TVA release the 2019 Final IRP and EIS?
TVA released the 2019 Final IRP and EIS on June 28, 2019. TVA released the IRP as Volume I and the EIS as Volume II. They are available on this IRP webpage. The 2019 IRP Recommendation, which is included in Volume I, offers ranges to provide a general guideline for resource selections.

What were the key results of the IRP study?
The IRP study demonstrates that TVA will continue to provide low-cost, reliable and clean electricity into the future and that resource additions will build on TVA's existing diverse asset portfolio. IRP study results show:

- There is a need for new capacity in all scenarios to replace expiring or retiring capacity.

- Solar expansion plays a substantial role in all futures.
- Gas, storage and demand response additions provide reliability and/or flexibility.
- No baseload resources (designed to operate around the clock) are added, highlighting the need for operational flexibility in the resource portfolio.
- Additional coal retirements occur in certain futures.
- Energy efficiency levels depend on market depth and cost-competitiveness.
- Wind could play a role if it becomes cost-competitive.
- In all cases, TVA will continue to provide for economic growth in the Tennessee Valley.

How was the IRP process conducted?
TVA used an integrated, least-cost framework that considered multiple views of the future to determine how potential power-generation resource portfolios could perform in different market and external conditions. We conducted the IRP process in a transparent, inclusive manner that provided numerous opportunities for public education and participation. Stakeholders and the public provided invaluable input that helped shape the IRP.

What was TVA's goal in developing the IRP?
In a rapidly changing business and regulatory environment, our goal with the IRP was to identify guideline ranges for an optimal energy resource plan that enables integration of renewables and distributed energy resources and that performs well under a variety of future conditions.

2 — The Recommendation in the 2019 Integrated Resource Plan

In general terms, can you explain what the Recommendation is?
The Recommendation offers ranges to provide a general guideline for resource selections. In developing a Recommendation from the study, TVA elected to establish guideline ranges for key resource types (owned or contracted) that make up the target power supply mix. This general planning direction is expressed over the 20-year study period while also including more specific direction over the first 10-year period. We believe meeting our future needs in accordance with the resource technologies and ranges in this Recommendation will position TVA to continue to deliver low-cost, reliable and clean power to the people of the Tennessee Valley. The IRP Recommendation meets the dual objective of ensuring flexibility to respond to the future while providing guidance on how our resource portfolio should change as the future unfolds.

What are the guidelines in the Recommendation?
The guidelines in the Recommendation are:

- **Coal**: Continue with announced plans to retire Paradise in 2020 and Bull Run in 2023. Evaluate retirements of up to 2,200 MW of additional coal capacity if cost-effective.
- **Hydro**: All portfolios reflect continued investment in the hydro fleet to maintain capacity. Consider additional hydro capacity where feasible.
- **Energy Efficiency**: Achieve savings of up to 1,800 MW by 2028 and up to 2,200 MW by 2038. Work with our local power company partners to expand programs for low-income residents and refine program designs and delivery mechanisms with the goal of lowering total cost.
- **Demand Response**: Add up to 500 MW of demand response by 2038 depending on availability and cost of the resource.
- **Nuclear**: Pursue option for secondary license renewal of Browns Ferry for an additional 20 years. Continue to evaluate emerging nuclear technologies, including Small Modular Reactors, as part of technology innovation efforts.
- **Wind**: Existing wind contracts expire in the early 2030s. Consider the addition of up to 1,800 MW of wind by 2028 and up to 4,200 MW by 2038 if cost-effective.

- **Storage**: Add up to 2,400 MW of storage by 2028 and up to 5,300 MW by 2038. Additions may be a combination of utility and distributed scale. The trajectory and timing of additions will be highly dependent on the evolution of storage technologies.
- **Gas Combustion Turbine**: Evaluate retirements of up to 2,000 MW of existing combustion turbines if cost-effective. Add up to 5,200 MW of combustion turbines by 2028 and up to 8,600 MW by 2038 if a high level of load growth materializes. Future CT needs are driven by demand for electricity, solar penetration, and evolution of other peaking technologies.
- **Gas Combined Cycle**: Add between 800 and 5,700 MW of combined cycle by 2028 and up to 9,800 MW by 2038 if a high level of load growth materializes. Future CC needs are driven by demand for electricity and gas prices, as well as by solar penetration that tends to drive CT instead of CC additions.
- **Solar**: Add between 1,500 and 8,000 MW of solar by 2028 and up to 14,000 MW by 2038 if a high level of load growth materializes. Additions may be a combination of utility and distributed scale. Future solar needs are driven by pricing, customer demand, and demand for electricity.

3 — Near-Term Actions and Longer-Term Planning

Are there near-term actions that TVA has identified, based on the IRP?
Results indicate there are near-term actions that would provide benefit across multiple futures:

- Add solar based on economics and to meet customer demand.
- Enhance system flexibility to integrate renewables and distributed resources.
- Pursue option for license renewal for TVA's nuclear fleet.
- Evaluate engineering end-of-life dates for aging fossil units to inform long-term planning.
- Evaluate demonstration battery storage projects to gain operational experience.
- Conduct market potential study for energy efficiency and demand response.
- Collaborate with states and local stakeholders to address low-income energy efficiency across the Valley.
- Collaboratively deploy initiatives to stimulate the local electric vehicle market.
- Support development of Distribution Resource Planning for integration into TVA's planning process.

Are there key signposts to guide decisions in the longer term?
As the future unfolds, TVA will monitor key signposts that will guide decisions in the longer term. The signposts relate to key variables that could have a significant influence on the future generation portfolio. These key signposts include:

- Demand for electricity
- Natural gas prices
- Customer expectations
- Regulatory requirements
- Operating costs for existing units
- Solar and wind costs
- Emerging and developmental technologies.

How will TVA know when it is time in the future to make changes to its resource portfolio?
TVA will monitor key signposts that will guide decisions in the longer term. Portfolio shifts will be driven by changing market conditions, more stringent regulations and technology advancements.

4 — Collaboration With Customers and Stakeholders

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Did TVA work with external stakeholders?
TVA engaged external stakeholders to understand diverse opinions and to challenge assumptions. TVA established the IRP Working Group, whose 20 members represented diverse interests in the Valley. The IRP Working Group met almost monthly from February 2018 to June 2019, and its members provided their respective views throughout the process. TVA also presented IRP progress updates to the Regional Energy Resource Council (RERC), a federal advisory committee that provides advice to the TVA Board on a range of energy-related matters, including the IRP.

What was the process for creating the IRP Working Group and who were the members?
The IRP Working Group was comprised of individuals from local power companies, directly served customers, industry groups, environmental and energy advocacy groups, academia, research institutions, community and sustainability representatives, and business and economic development professionals. The members represented the broad perspectives of those who live and work in the Valley.

Can you offer a more specific breakdown of the representatives in the 2019 IRP Working Group?
The 2019 IRP Working Group included both customer and stakeholder representatives. There were eight customer representatives, including:

- Three local power companies
- Three industrial customers
- Two organizations representing local power companies and industrial customers.

There were 12 stakeholder representatives, including:

- Three energy and environmental non-governmental organizations
- Three from research and academia with expertise in distributed energy resources (DERs)
- Two from state government
- Two representing economic development
- Two representing community and sustainability interests.

The IRP Working Group reflected the geographic diversity and interested groups of the Tennessee Valley. The names of IRP Working Group members are included in the Final IRP.

5 — IRP and EIS Project Timeline

Can you provide a quick look at the timeline?
Developing the IRP is a long process. The timeline included:

60-day EIS public scoping period	February 15 to April 16, 2018
Public scoping meetings	February 2018 - March 2018
Modeling, analysis and public updates	June 2018 - January 2019
Draft EIS and IRP published	February 2019
Public meetings & comment period	February 15 to April 8, 2019
Refinement of analysis, public updates	Early Summer 2019
Publication of Final IRP and EIS	June 28, 2019
Board approval of the IRP Recommendation	August 22, 2019
Record of Decision published	September 2019

What did the 2019 IRP planning process entail?
TVA and its stakeholders started the IRP planning process in February 2018. The process included:

- A 60-day public scoping period in spring 2018 to obtain public comments on the scope of the effort to develop the IRP.

- After extensive research, discussion and consideration of scoping comments, TVA, in coordination with the IRP Working Group, identified six scenarios — future worlds outside TVA's control — that might alter its operating environment and affect the cost of electricity and possible resources over the next 20 years.
- In coordination with the IRP Working Group, TVA also developed five business strategies that TVA could apply in the future to provide power in each scenario.
- An extensive computer modeling process applied each strategy to each scenario, resulting in 30 "resource portfolios."
- The draft IRP and EIS were released on Feb. 15, 2019. The draft IRP included information on each portfolio, and the draft EIS assessed the impact of each portfolio on the environment, economy and population in the Tennessee Valley.
- Based on stakeholder and public input from the public comment period, TVA performed sensitivity analyses to address questions that merit additional evaluation.
- TVA completed the study, which includes the IRP Recommendation, near-term actions and key signposts, and the final environmental assessment.
- Publication of the Final IRP and EIS on June 28, 2019.
- Board approval of the 2019 IRP Recommendation on August 22, 2019.

What happens next?
Now that the TVA Board of Directors has approved the 2019 IRP Recommendation, TVA will prepare the Record of Decision, which is expected to be published in September 2019.

6 — Integrated Resource Plan (IRP) — General Questions

How does TVA define "customer?"
Customers are businesses that TVA sells power to, including local power companies and industrial customers. As the nation's largest public power provider, TVA delivers safe, reliable, clean, competitively priced electricity to 154 local power companies and 58 directly served customers.

Why is the IRP important?
The utility marketplace is changing rapidly, and long-range planning is necessary to guide TVA's decisions about power generation. The IRP also will inform TVA's next Long-Range Financial Plan.

What is the purpose of the IRP?
The purpose of the IRP is to provide TVA with direction on how to best meet future electricity demand. The IRP considered many views of the future to help determine how TVA can continue to provide safe, reliable energy at the lowest feasible rate; support environmental stewardship; and foster economic development in the Valley over the next 20 years. The IRP process examined a variety of economic, regulatory and market-driven scenarios (outside TVA's control) and strategies (within TVA's control) to help TVA respond to changing energy demands while continuing to provide reliable power at the lowest possible cost. The IRP is like a compass, not a GPS, in that it provides a broad direction and not a direct route.

Does the IRP have a particular area of focus?
The 2019 IRP emphasizes the importance of flexibility in response to the changing energy marketplace. TVA evaluated a wide range of possible futures and how flexible the power system needs to be to ensure reliable power at the lowest system cost. These possible futures include increasing renewables and distributed energy resources (DER), driven by technology advancements as well as the improving economics and accessibility of those technologies.

Why is TVA focused on flexibility?

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TVA is focused on flexibility because it needs a diverse power-generation system that is well-positioned to meet future demand; has the capacity to incorporate renewable energy sources and DER along with more traditional resources; and has the capability to respond in a variety of circumstances well into the future.

How does the IRP address local impacts?
The IRP is a high-level, broad planning process, and generally does not delve into local, site-specific impacts. TVA evaluates local impacts in future documents, after a specific proposal is developed.

How did the IRP process consider uncertainties?
Considering uncertainties is an important part of the IRP planning process, because uncertainties can impact electricity demand as well as costs or performance of certain energy resources. TVA identified uncertainties and used them as building blocks to construct the scenarios, which are situations beyond TVA's control that could impact power generation. TVA's list of uncertainties for the 2019 IRP includes electricity demand, market power price, natural gas prices, coal prices, solar prices, storage prices, regulations, CO_2 regulation/price, distributed generation penetration, energy efficiency adoption and economic outlook (national and regional).

How will the IRP impact people with limited incomes?
A primary focus area of the IRP is least-cost planning. The IRP process considered, "How can TVA provide reliable service for the lowest cost?" That focus is in the best interest of all customers, especially customers with limited incomes. TVA also prepared an Environmental Impact Statement (EIS) to assess the impacts associated with the implementation of the updated IRP. Among other factors, the EIS evaluated socioeconomic impact and environmental justice to ensure that decisions in the IRP do not have a disproportionate impact on disadvantaged communities.

Does the 2019 IRP consider additional renewable power sources?
TVA's 2019 IRP considers many views of the future and different generation resources, including coal, natural gas, nuclear, hydro, solar and other renewables that can be used — along with energy efficiency and other distributed energy resources — to meet future electricity demand. TVA also will consider how its current generating sources can best be used to meet demand. This plan focuses on the best way to ensure reliability and meet power demand at the lowest feasible cost.

Did TVA set a standard for the relative quantity of renewables?
Renewable energy will be a key resource in TVA's future energy mix. With TVA's planning approach, all resources including renewables were on a level playing field where their individual characteristics and strengths played in the model to determine an optimal portfolio. Some states have renewable portfolio standards which mandate a certain amount of renewables. For most of the TVA region, such mandated levels do not exist, so we were free to allow the resource characteristics to interact in the model to determine an optimal level of specific resources. TVA has several criteria for an optimal resource plan: low cost, risk informed, environmentally responsible, reliable, diverse and flexible. The optimal plan best meets all criteria.

How does the IRP define renewables use?
Since the IRP is more like a compass than a GPS, it directionally defines ranges of renewables that could be added by a future date, but it does not define specific locations for renewables. TVA focused on the best way to ensure reliability and meet power demand at the lowest feasible cost.

Can you explain what is meant by DERs?
Distributed Energy Resources (DER) include resources and services such as generation sources (including renewable power sources) connected to the distribution system, energy storage, demand response, and energy efficiency programs.

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Did TVA consider a strategy to incentivize more DER implementation in the Valley?
TVA evaluated traditional and distributed resources in this IRP. Strategy B (Promote DER) tested the impact of incenting DER to achieve higher, long-term penetration levels in the Valley. TVA looked at the cost, value and impact of these resources on its load shape. TVA looked at portfolios of DER resources that would create the best value to all ratepayers.

How did nuclear figure into the process?
TVA operates an 8,000-megawatt (MW) nuclear fleet today. Three of TVA's seven nuclear units will need to be relicensed between 2033 and 2036, which is within the 20-year study window of this IRP. The 2019 IRP evaluated how optimal generation portfolios would be affected by the decision to relicense those units. TVA considered a variety of power-generation resources in the IRP, including large and small-scale nuclear technologies.

Does the IRP or the EIS address any recommended changes to the Hydro discharges, specifically the "guaranteed" minimum reservoir flows?
While the IRP has metrics around water use, considerations such as changes to minimum reservoir flows, hydro discharges and river management practices are outside the scope of the IRP and are better addressed through other programmatic efforts such as TVA's Reservoir Operations Study.

Where do electric vehicles and associated charging infrastructure fall within the IRP?
In general, this falls under electrification and a sector that could increase demand for electricity, but specific locations for charging infrastructure will not be an outcome of the IRP.

Is there a difference between reliability and resiliency?
Yes. Reliability addresses the ability to meet electricity demand reliably, while resiliency is an aspect of reliability that addresses more specifically the ability to withstand and recover from weather and other external disruptions. Both reliability and resiliency are critical for serving customer needs. TVA has a diverse system that is well-positioned to meet demand, and the IRP helps TVA evaluate what the future may look like and how flexible the system may need to be to ensure reliability and resiliency.

Did TVA evaluate resiliency in this IRP?
Resiliency is a critical aspect of providing power. Cybersecurity measures and investments to harden transmission and distribution systems are examples of some ways to improve resiliency, but they are outside the scope of the IRP. A system that is flexible in its ability to respond to dynamic loads is more resilient. While the IRP takes a systemwide view and is not location-specific, flexibility of potential portfolios was evaluated.

How were the comments during the scoping phase of the IRP process used?
The scoping process was at the beginning of the IRP process — from February 15 to April 16, 2018. Comments received during the scoping period helped TVA identify issues important to the public, and they helped lay the foundation for development of the IRP and the EIS. Click here for the Scoping Report.

When were the draft IRP and EIS released?
The draft IRP and EIS were released on Feb. 15, 2019. The draft IRP included information on each portfolio, and the draft EIS assessed the impact of each portfolio on the environment, economy and population in the Tennessee Valley.

What work was done after the release of the draft IRP and EIS?

After the draft, TVA held a public comment period from Feb. 15 to April 8, 2019. Based on input from stakeholders and the public, as well as based on a comprehensive review of the initial modeling results, TVA performed sensitivity analyses to address questions that merited additional evaluation. TVA considered public input, the sensitivities, along with the balance of the portfolio results, when developing the 2019 IRP Recommendation. TVA reviewed and incorporated public comments in preparation of the Final IRP and EIS. All comments and responses appear in the Final EIS.

What sensitivities did TVA evaluate?
When analyzing results from the draft IRP, TVA identified issues that warranted further evaluation prior to finalizing the study. In addition, TVA received helpful input from the IRP Working Group and the RERC as well as from the public during the comment period. Many of the questions raised by TVA, stakeholders and the public focused on certain key assumptions that could influence results. To explore the impacts of changes in key assumptions and to inform the Recommendation, TVA evaluated sensitivities related to the following categories: natural gas prices; lower wind costs; greater energy efficiency (EE) and demand response (DR) market depth; integration cost and flexibility benefit; pace and magnitude of solar additions; higher operating costs for coal plants; more stringent carbon constraints; and variation in climate.

What did TVA consider when developing its Recommendation?
The IRP results — including the 30 primary cases and the sensitivity cases — provide a robust set of potential resource additions and retirements, and the final Recommendation is derived from this evaluation. The Recommendation takes into account customer priorities around power cost and reliability across different futures, along with environmental stewardship and Valley economics considerations. In developing a recommendation from the study, TVA elected to establish guideline ranges for key resource types (owned or contracted) that make up the target power supply mix. In order to distill the considerable number of cases evaluated through the original scenario and strategy analysis and the sensitivity cases, the Recommendation uses ranges that are centered on results obtained under the Current Outlook scenario. The other scenario and sensitivity results provide a sense of how the recommended mix might change as the future changes. Recognizing that a variety of future scenarios are possible and each strategy has positive aspects, all IRP results are included in the Recommendation to provide flexibility for how the future evolves. Implementing the least-cost resource plan with all of these priorities in mind will help ensure TVA continues to fulfill its mission to serve the people of the Tennessee Valley.

7 — Environmental Impact Statement (EIS) — General Questions

Did TVA consider environmental impacts of the IRP?
Yes. As part of the study, TVA prepared a programmatic Environmental Impact Statement (EIS) to assess the natural, cultural and socioeconomic impacts associated with the implementation of the updated IRP.

What effects are evaluated in the EIS?
The effects examined in the EIS include:

- Emissions of greenhouse gases
- Fuel consumption
- Air quality
- Water quality and quantity
- Waste generation and disposal
- Land use
- Ecological
- Cultural resources
- Socioeconomic impacts and environmental justice.

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What does the scope of the EIS include?
The EIS analyzes and identifies the relationship of the human environment and economy to each of the different scenarios and strategies being considered in the IRP.

What are the environmental impacts identified in the EIS?
The EIS identified that:

- Under all the portfolios, there is a need for new capacity with a significant expansion of solar generation overall.
- Uncertainty around future environmental standards for carbon dioxide emissions, along with the outlook for loads and gas prices, are key considerations when evaluating potential coal retirements.
- Emissions of air pollutants, the intensity of greenhouse gas emissions and generation of coal waste decrease under all strategies.
- Strategies focused on resiliency, load shape and renewables have the largest amounts of solar and storage expansion and coal retirements, resulting in lower environmental impact overall but higher land use.
- For most environmental resources, the impacts are greatest for the No Action alternative. The exception is the land area required for new generating facilities, which is greater for the action alternatives, particularly strategies which focus on resiliency, load shape and renewables.

Does the EIS consider the CO_2 emissions and global warming impacts of the various IRP scenarios? If so, how?
The EIS considers CO_2 and global warming impacts, and portfolios have been evaluated against metrics to determine the environmental impact. The EIS addresses the effects of power production on the environment, including climate change, the effects of climate change on the Valley, and air emissions and water use in TVA's power operations.

8 – Public Comment Period (February 15-April 8, 2019)

What was the purpose of the public comment period?
The IRP and EIS were developed with public input. Throughout the IRP process, TVA looked for opportunities to engage external stakeholders to understand diverse opinions and to challenge assumptions. After publishing the draft IRP and EIS on Feb. 15, 2019, TVA held a public comment period from Feb. 15 to April 8, 2019. The comment period offered numerous ways for the public to learn more about the draft and to provide input. An interactive report about the IRP was — and still is — available via the IRP webpage, and people were encouraged to provide comments there. TVA also hosted a public webinar on Feb. 26 and a series of public meetings across the Tennessee Valley during the comment period. Please see Section 9 below for questions and answers from the public webinar.

When and where were public meetings be held?
Public meetings were held on:

- **Feb. 19** in Murfreesboro, Tenn., at an open house and listening session with the Regional Energy Resource Council.
- **Feb. 27** in Knoxville, Tenn. (39 attendees)
- **March 18** in Memphis, Tenn. (56 attendees)
- **March 19** in Huntsville, Ala. (48 attendees)
- **March 20** in Chattanooga, Tenn. (31 attendees)
- **March 21** in Nashville, Tenn. (99 attendees)
- **March 26** in Bowling Green, Ky. (17 attendees)

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9 — Questions and Answers from February 26, 2019, Webinar

Note: *TVA's answers in this section were provided in spring 2019, based on the information in the draft IRP and draft EIS. During the public comment period, TVA received more than 1,200 comments about the 2019 IRP and EIS. The comments and TVA's responses are published in the final EIS.*

It seems hard to plan for how the future will be in 20 years. I know you talked about this, but can you explain how you plan so far out?
Our IRP is based on a "scenario" planning approach. It helps us understand how future decisions could play out in a variety of future scenarios. At the same time, we considered a wide variety of resource options that could be available to produce power and looked at business strategies that TVA could apply in any possible future. That approach improves the likelihood that our plan will provide reliable and least-cost solutions to meet demand for electricity, regardless of how that future plays out. With that said, we will keep an eye toward key signposts such as loads, commodity prices, regulations, etc., and determine when to conduct the next IRP. The IRP is a 20-year plan, but it is not necessarily good for 20 years. We did IRPs in 2011, 2015 and this is 2019, so it really depends on how rapidly the future changes relative to the current IRP.

Can you speak about how the 30 portfolios will play out moving forward with this plan?
As background on how we got to 30 portfolios: After extensive research, discussion and consideration of scoping comments, TVA, in coordination with the IRP Working Group, identified six scenarios — future worlds outside TVA's control — that might alter its operating environment and affect the cost of electricity and possible resources over the next 20 years. In coordination with the IRP Working Group, TVA also developed five business strategies that TVA could apply in the future to provide power in each scenario. An extensive computer modeling process applied each strategy to each scenario, resulting in 30 "resource portfolios." As we move from the draft to the final and develop the recommendation, we won't pick a certain portfolio out of the 30 that are included in the draft. We will determine which strategy or combination of strategies TVA would want to employ and how flexible it is to meet the needs of whatever scenario plays out. While the portfolios are helpful for looking at the results at this point, the future is not going to play out exactly as described in one of those portfolios.

The draft IRP shows no new solar resources added until 2023. How will TVA address renewable energy between now and then?
At the time that we locked in our base case for the IRP, it was prior to signing the recent solar contracts for Facebook and Google. While there is no immediate need to add resources to the portfolio, we do expect to add solar sooner than 2023 to continue helping customers meet their renewable goals. Between the draft and the final IRP Report, we are evaluating the potential impacts of accelerating solar to meet those needs. Another key factor is the trajectory of solar pricing, and our forecasts tell us that as we approach the mid-2020s, that is the most economic time to add solar. That said, we will continue to monitor solar pricing in the market and, if it is advantageous to add it sooner, that is something we would be looking to do.

Is there any scenario with no solar?
All 30 portfolios contain some amount of solar, ranging from 4 to 9 gigawatts (GWs) of incremental nameplate capacity by 2038.

I understand the approximately 700 MW nameplate solar announced last fall was not included in the base case. Will that amount come out of future planned solar?
It is an acceleration of the amount of solar that is included in the base case. A sensitivity is being run to determine the net effect of that acceleration on how much solar is added over the 20-year study period.

Did you model an increased trajectory of industrial and commercial customers converting their

demand to distributed solar? If so, how?
Yes, we have looked at increased penetration levels of distributed solar both in a scenario (outside of TVA's control) and in a strategy (within TVA's control). See Appendix E for Scenario Design and Appendix F (of Volume I) for Strategy Design for additional details.

Do you expect any liberties to be extended to the LPCs to allow them to contract directly for renewable resources?
The Flexibility Research Project (FRP) pilot provides an avenue for participating Local Power Companies to provide solutions that address behind-the-meter opportunities. Examples of potential solutions include community solar to meet local customer demand as well as commercial and industrial onsite generation to complement local solar generation.

Was there an RFP issued by TVA to test any assumptions about wind? Why is wind not added, since it seems to be reasonably priced?
TVA conducted a renewables RFP within the last year, which helped establish initial pricing assumptions for wind that included both in and out-of-Valley options. There is less wind intensity in the Valley, which poses some challenges. Out-of-Valley wind from the Midwest is more efficient, but it is costly to transmit to our region. Wind generation is variable across all hours and months, at times blowing when not needed. It does contribute to winter need on the coldest days, but only to the tune of about one-third of its nameplate. Solar generation can be efficiently produced in-Valley, it matches up well with the warm and hot summer weather we experience, and it contributes about two-thirds of its nameplate to help meet demand on the hottest days. Finally, solar prices have come down appreciably more than wind prices have over the past five years, making forecasted solar prices about 40 percent lower than wind prices by the mid-2020s. Between the draft and the final, we are performing additional analysis, including looking at resources that were promoted and not selected. Wind is one of them, and we are doing a break-even analysis to determine how much lower wind pricing would need to be to be economic. We will consider these results in the final recommendation.

Did TVA consider contracts or relying on bordering markets versus self-supply in the IRP?
Yes. Specifically, for wind, we considered out-of-Valley wind, since the resource is more attractive outside the Valley than inside the Valley. As far as buying power from other markets, we have considered those import limitations that we have with neighboring systems.

Is TVA eliminating energy efficiency programs?
TVA is not eliminating energy efficiency programs. Fortunately, energy efficiency has increased due to Department of Energy code and standard changes in which new appliances, lighting and HVAC systems are using significantly less energy at the commercial, industrial and residential scales, independent of the electric utility. Due to these other drivers in the industry, TVA has reduced emphasis on energy efficiency programs because there is less need for programmatic energy efficiency. TVA's position is to allow the market to drive that efficiency broadly and for us to focus our efforts on particular areas where programmatic energy efficiency is most needed. TVA is committed to low-income energy efficiency programs. Our Home Uplift partnership with local power companies in the Valley is a good example of that, and we are looking into the best ways to expand that program.

What is TVA doing to ensure it will be providing the cleanest energy possible in the future?
Environmental stewardship is one of the key aspects of TVA's mission and in this IRP. Based on draft results, TVA expects to add anywhere from 4 to 9 GW of solar over the next two decades. All of the portfolios include a significant amount of solar additions, and we see a projected 70 percent average reduction in CO_2 intensity from the 2005 baseline. We are also focusing on ways to encourage the use of electric appliances and equipment that are cost-effective and reduce overall carbon emissions across the economy.

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Which strategy is the most-aggressive in pursuing renewables?
The strategy that most-aggressively pursues renewables is Strategy E (Promote Renewables). But there is also a significant amount of solar that is built out in Strategy C (Promote Resiliency) and Strategy D (Promote Efficient Load Shape). We see 4 to 9 GWs of solar built out over the 20-year period, and we see it toward that upper bound in Strategies C, D and E.

Why is promoting renewables (Strategy E) a relatively poorer choice in terms of land use?
Strategies with the highest solar additions resulted in the highest land use. The facility land requirement is the land area permanently disturbed by the construction of the
generating unit. Facility land requirements were determined from a variety of sources, including characteristics of TVA facilities, both existing and under development; characteristics of comparable facilities recently constructed or proposed elsewhere in the country; and various published reports on this topic.

What tools does TVA use to promote an efficient load shape?
There is a strategy in the draft IRP called Promote Efficient Load Shape, and it emphasizes energy efficiency, demand response, electrification and storage. Those were the primary tools we evaluated in this draft to promote that. We were trying to find energy efficient ways to reduce the peaks. Electrification can have other advantages, such as reducing carbon from more carbon-intensive processes and filling lower levels in our load shape. Demand response also plays a key role in this. Our draft results do assume continuing programs with interruptible pricing and program products with our customers as we have today. That is something important to continue. One last thing we evaluated in this regard is that as the future might evolve to have more electric vehicles in the Valley, there may be additional ways to manage load shape there. We did evaluate in Strategy D (Promote Efficient Load Shape) the potential to apply a time-of-use structure to charging electric vehicles and distributed storage (batteries) that would help shift the load shape as well. Those are the tools that were evaluated in our analysis.

What were the assumptions of any improvements in electrical storage capacity (i.e. large scale battery storage), especially as it might apply to solar power?
TVA's forecasts for storage and solar costs are included in Appendix C of the IRP. Strategies tested different levels of solar and storage penetration.

What storage resources are being developed?
As detailed in Chapter 5 and Appendix A of the IRP, TVA included pumped storage, battery storage, compressed air storage, fuel cells, and advanced chemistry batteries in the 2019 IRP.

How do improvements to distribution or smart grid technology factor in to any of the strategies?
We don't model improvements on the transmission or distribution systems in the IRP. However, with the levels of DER and utility-scale capacity considered in this IRP, there will likely be upgrades needed once specific projects are identified in the future.

Can you help me better understand carbon reduction in various scenarios?
On average, carbon emissions are reduced 70 percent from a 2005 baseline depending on the scenario. The Valley Load Growth scenario results in the least carbon reduction due to the increase in demand. However, this scenario has the highest penetration of electric vehicles, which would avoid emissions from the transportation sector which would not be captured in the IRP metrics. The other scenarios result in different carbon reductions dependent on the resources that are included in those portfolios. Those with more solar, storage and nuclear tend to have better carbon performance.

Decarbonization is included as required by federal regulations. How was the potential for federal

regulations becoming more stringent modeled? Was the Intergovernmental Panel on Climate Change (IPCC) report calling for deep cuts in greenhouse gas emissions by 2030 taken into account in analysis?
As described in Appendix E, TVA developed five different future environments with robust input from the IRP Working Group which, coupled with the TVA's Current Outlook, constitute the six scenarios in the 2019 IRP. The overarching principle in the design of scenarios was to ensure a wide range of possible outcomes. The Decarbonization scenario represents a plausible future in which a CO_2 emission penalty is applied to the utility industry in an effort to curb greenhouse gas emissions. The CO_2 penalty used in the Decarbonization scenario was developed based on the Minnesota Public Utilities Commission (PUC) Notice of Updated Environmental Externality Values (June 16, 2017). The notice states "the Commission established an estimate of the likely range of costs of future carbon dioxide regulation on electricity generation of $9/ton to $34/ton for CO_2 emitted in 2022 and thereafter." Several other states (CO, NY, IL) made decisions to integrate social cost of carbon estimates into utility planning around this same time period. TVA's 2019 IRP scenario development began in November 2017, shortly after this information became available. Based on this information, TVA used an average of $22/ton derived from the $9/ton and $34/ton but used 2025 as the starting year based on regulatory development timelines from introduction of legislation to effective date of final regulation. Since the scenario was originally developed, the Minnesota PUC published an updated order on January 3, 2018. The updated CO_2 cost values in 2025 are from $10.07 to $46.96/ton (2015$). Due to comments received from the IRP Working Group and the public at large, TVA is conducting a sensitivity on the carbon penalty in the Decarbonization scenario by doubling the $22/ton to $44/ton beginning in 2025. This sensitivity aligns to the latest update from the Minnesota PUC, which is largely based on the Federal Social Cost of Carbon, which included information from the IPCC. The Valley Load Growth scenario represents a plausible future in which rapid economic growth, technology-driven investments, and a rapid pace of electric vehicle adoption raise electricity use and result in higher energy sales. The CO_2 penalty used in the Valley Load Growth scenario is roughly one-third of the Decarbonization scenario and represents a proxy for policy actions that future administrations may undertake as the robust economic situation provides the means to pay for the societal preference for lower emissions.

Can you address how uncertainties, such as the cost of gas or solar, were considered in the analysis?
In the scenarios, each of the different views of the future had implications to the cost of solar or gas. They were part and parcel of the scenarios we evaluated, understanding that the cost of these resources is a key uncertainty. That played out in the evaluations we took a look at. We are doing high- and low-gas sensitivity analysis between the draft and the final to speak to some boundary cases of how much of an impact a very high or a very low gas price could have on results.

Has TVA calculated the change in wholesale kilowatt hour (kWh) cost each scenario represents. If so, would they share it?
We have calculated the change in system average cost in $/MWh to give us an indication of rate pressure as detailed in the draft IRP document. However, specific changes to wholesale rates are outside the scope of the IRP.

Are the assumptions for each scenario available for review? What are the assumptions regarding impact on local utility cooperatives, particularly regarding distribution and infrastructure upgrades?
Yes, the assumptions for each scenario are detailed in the IRP document, specifically the appendix on scenario development. The IRP is not location-specific and does not identify distribution or infrastructure upgrades.

Does TVA expect prices to go up, down or stay the same in a scenario promoting more solar and flexibility through natural gas and/or storage?

Cost metrics suggest that the Present Value Revenue Requirements (PVRR) and system average costs would increase in those strategies that promote solar and storage.

Given that Memphis Light, Gas and Water (MLGW) is studying options to replace/leave TVA, is TVA adding a scenario in the IRP that addresses an exit by MLGW?
TVA did not specifically study this potential situation, but it did model a load loss scenario as a proxy for any type of load loss of this scale to better understand how outcomes from each strategy could be affected by large load loss.

Current small modular reactors (SMRs) are being developed to add flexibility, including load following. If available, would this weight higher in a given portfolio that includes SMRs, since it both provides baseload power and flexibility?
There is potential as this technology evolves for it to play more of a role. Certainly, SMRs have greater flexibility than larger scale nuclear, and that was already evident in our analysis. As the work around the technology continues to evolve, it is something we will continue to look at and evaluate how it might play. This is one of the technologies that was not selected for economic reasons as a lower-cost choice, but we are doing a break-even analysis to inform how SMRs could contribute to the portfolio and how much lower costs would have to be for it to be economical.

What nuclear remains? Is there a transition plan to retire Nuclear and increase EE/Renewable?
The only scenario that envisions nuclear retirements is the No Nuclear Extensions scenario where Browns Ferry 1-3 are retired. All other scenarios (and strategies) retain the existing nuclear fleet. The Promote Resiliency strategy adds 1200 MW of small modular reactors.

Did TVA give serious consideration to biomass as a resource?
Biomass was offered as a renewable option. In terms of the need for the system and the fit, biomass was not selected based on its energy profile and cost. Based on economics, the model chose flexible resources, so we did see a lot of gas selected and solar as the renewable resource, because its profile matched to our system's need. The model shows solar as more economical, but biomass was considered and further information around that is included in the draft IRP.

The focus on renewables seems out of sync with TVA's focus on reliability. The two don't seem to go together. Can you address this?
TVA will continue to be focused on reliability. We have delivered 99.999% reliable electricity for the past 20 years and will continue to do that at the lowest feasible cost. The cost of renewables, specifically solar, has continued to decline and is being selected as an economical resource to provide energy to the TVA system along with traditional resources such as nuclear, hydro, coal and natural gas. The IRP considers both utility-scale and distribution-scale renewable options.

What definition of resiliency is TVA using? There are any number, often contradictory, in current use.
We have gone generally with the consensus definition. Most incorporate these thoughts: that resiliency involves preventing disruptions to the system and responding rapidly to any external disruptions on the system. Flexibility plays into the first piece. To have a resilient system, if we have flexible assets that can respond to dynamically changing levels of need for energy across the system, that helps prevent disruption. And then, having both TVA assets and some distributed energy resources help respond to system-wide and local needs for resiliency when recovering from an event that might occur.

You mentioned that the IRP is focused on flexibility. How will that impact my electricity?
We are focused on flexibility to respond to the changing energy marketplace. We are focused on flexibility because we need a diverse power-generation system that is well-positioned to meet future demand; has

the capacity to incorporate renewable energy sources and DER along with more traditional resources; and has the capability to respond in a variety of circumstances well into the future. Our goal is to continue to provide reliable, clean and affordable electricity, and we feel that planning for flexibility will allow us to do that.

How are the announced retirements of Paradise and Bull Run being addressed in this IRP?
Because those potential retirements were under evaluation as we were developing the draft IRP, we added a sensitivity to consider that impact of those potential retirements in the draft. There is discussion around that in the draft IRP. Because these decisions have now been finalized, the plant retirements will become part of the base case. Between the draft and the final, we have revised these 30 portfolios to reflect the decision of the TVA Board.

Is coal to be eliminated as a resource going forward?
As a result of the Board decisions to retire Bull Run and Paradise 3, we have taken those two coal units out of the base case, but there still is a significant amount of coal in our portfolio going forward. Just like any resource in our portfolio, it is an option in this IRP to retire those. It is all based on the operating costs of those units going forward. You will see portfolios that retire additional coal, but you also will see portfolios where the value of that coal is enough to have it continue in our portfolio over the next 20 years. Even in a scenario where we have tried to envision a regulatory driver on carbon, you will see how that affects the coal portfolio, but there is some coal in all of the 30 portfolios for 20 years. Between now and the release of the IRP, we are doing some additional analysis on carbon. We are doubling the penalty from the Decarbonization scenario to see how that impacts the existing TVA coal fleet.

Once a coal-fired plant has been identified as a site to be closed, how will TVA make the decision to remove all coal ash on that site?
The programmatic EIS associated with the IRP evaluates the potential environmental and socioeconomic impacts of the various portfolios on the entire Tennessee Valley. For portfolios in which TVA has identified potential retirements, the action of ceasing operations at the plant have been analyzed, including the reduction in emissions, fuel consumption, waste production etc. If TVA were to decide to retire a particular coal facility, actions associated with the deconstruction and demolition of that particular facility, as well as the subsequent use of the coal facility site, will be addressed in a future planning process that will include public and agency input.

Any exploration of better high-powered interconnections to MISO (Midcontinent Independent System Operator Inc.) to better access nearby generation across the Mississippi River? Did TVA consider bordering markets versus self-supply in the IRP?
The IRP is not location-specific so we did not consider additional interconnections at specific locations. As far as buying power from other markets, we have considered existing import limitations that we have with neighboring systems. We also have both TVA-build and PPA options in the IRP.

Do resilience scenarios include increased off-systems sales beyond what is currently allowed to accommodate intermittent variability (eg, law change to allow sales beyond neighbors' control areas currently allowed for balancing)?
No. Import and export limits are the same for all scenarios.

Who are the members of the Regional Resource Councils?
Members, meeting information, as well as the Regional Energy Resource Council Charter, are listed on TVA's website at www.tva.gov/rerc.

Rates-projections?

Rates are outside the scope of the IRP. We have included cost metrics to give an indication of how costs may change over time.

Generally how will TVA determine its preferred plan?
TVA will develop a recommendation based on a strategy or parts of strategies that perform well across the scenarios considered in the IRP. That approach improves the likelihood that our plan will provide reliable and least-cost solutions to meet demand for electricity, regardless of how that future plays out. As we developed the draft IRP, we identified questions and issues that warranted further evaluation before finalizing the IRP. We also gathered feedback from stakeholders; for example, from members of the IRP Working Group and Regional Energy Resource Council as well as from the public to help identify key areas that merit further analysis. We are reviewing and will address the public comments we received during the comment period. We are incorporating input into the final IRP Report. We will complete the IRP and final EIS this summer, and it will be made available to the public for at least 30 days before it is presented to the TVA Board of Directors. We expect to request approval of the IRP recommendation from the Board in August 2019. After it is approved, a Record of Decision will be published.

10 — 2015 IRP

Will there be a review of how TVA has implemented the 2015 IRP?
TVA continues to use the 2015 IRP as a guide as it makes decisions. The future has changed significantly since the 2015 IRP in regard to factors such as load and commodity price forecasts and technology improvements. As TVA analyzed potential future changes to the resource mix in the 2019 IRP, the previous power supply ranges from the 2015 IRP were considered in those evaluations. The 2015 IRP power supply ranges will continue to remain in place until the Record of Decision is issued on the 2019 IRP Recommendation.

Does TVA benchmark the resource planning processes and modeling used by other utilities across the country? How does that impact the IRP process?
Yes, TVA reviews other utility plans and collaborates with utility industry peers and partners to benchmark their resource planning modeling processes. For example, TVA evaluates how other utilities achieve flexibility and how they use distributed energy resources, and it considered its findings during the IRP process. Since TVA's IRP cannot directly match some of the assumptions and processes that others use, as part of its benchmarking, TVA considers the variations in climate, power demands and state regulation that other utilities incorporate in their planning. Further, TVA utilizes a third party to review and validate assumptions that go into the modeling process.

Does TVA use a backcasting or verification protocol to improve the accuracy of its forecasts?
Forecasting accuracy is important. TVA backcasts to determine how the forecast would have been different with actual input. The industry as a whole has seen a structural break in the relationship of economic drivers like GDP to load forecasts, prompting TVA and other utilities to recalibrate forecasting models to account for that change and other emerging trends and drivers.

Where can I find more information about the 2015 IRP?
Information is available on TVA's 2015 IRP webpage.