**Memorandum from the Office of the Inspector General**

September 30, 2015

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FINAL REPORT – AUDIT 2014-15080 – INTEGRATED RESOURCE PLANNING PROCESS

On November 19, 2013, we initiated a review of TVA's Integrated Resource Planning (IRP) process. Our objective was to evaluate the adequacy of TVA's development process for its 2015 IRP, including its demand-side and supply-side strategies. We issued three updates to staff during the course of the audit outlining findings and one process enhancement recommendation that was addressed during the course of the audit. We also obtained informal comments from TVA management that we incorporated into the final report.

This report is for your review and information. No response to this report is necessary. Information contained in this report may be subject to public disclosure. Please advise us of any sensitive information in this report that you recommend be withheld.

If you have any questions or need additional information, please contact me at (865) 633-7373 or Lisa H. Hammer, Director, Operational Audits, at (865) 633-7342. We appreciate the courtesy and cooperation received from your staff during the audit.

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OIG File No. 2014-15080

Office of the Inspector General

*Audit Report*

To the Executive Vice President and Chief Operating Officer, Executive Vice President and Chief Financial Officer, and the Executive Vice President, External Relations

# INTEGRATED RESOURCE PLANNING PROCESS

Audit Team
Operational Audits

Audit 2014-15080
September 30, 2015

# ABBREVIATIONS

| | |
|---|---|
| ACEEE | American Council for an Energy-Efficient Economy |
| AEO | Annual Energy Outlook |
| $CO_2$ | Carbon Dioxide |
| EE | Energy Efficiency |
| EEDR | Energy Efficiency and Demand Response |
| EEIX | Energy Efficiency Information Exchange |
| EIA | Energy Information Administration |
| EIS | Environmental Impact Statement |
| EPA | Environmental Protection Agency |
| ERM | Enterprise Risk Management |
| GAO | Government Accountability Office |
| HVDC | High-Voltage Direct Current |
| IRP | Integrated Resource Plan |
| IRPWG | Integrated Resource Plan Working Group |
| NEPA | National Environmental Policy Act |
| NERC | North American Reliability Corporation |
| NRC | Nuclear Regulatory Commission |
| O&M | Operating and Maintenance |
| PSP | Power Supply Plan |
| PVRR | Present Value of Revenue Risk Requirement |
| RERC | Regional Energy Resource Council |
| SEIS | Supplemental Environmental Impact Statement |
| TVA | Tennessee Valley Authority |
| TVRIX | Tennessee Valley Renewable Information Exchange |
| U.S. | United States of America |
| VP | Vice President |

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## APPENDICES

# Audit 2014-15080 – Integrated Resource Planning Process

## Executive Summary

### Why the OIG Did This Audit

The Tennessee Valley Authority (TVA) develops an Integrated Resource Plan (IRP) to guide the organization in meeting future energy demand. Development of the IRP contains steps for (1) obtaining internal and external stakeholder input, (2) identifying data to be included as inputs into the plan, (3) modeling the information, and (4) evaluating the modeling results. TVA began an update of the 2011 IRP and associated Environmental Impact Statement in October 2013 due to significant changes within the electric industry and TVA.

Due to the importance of the IRP as a directional document for TVA's future, we evaluated the adequacy of TVA's development process for the 2015 IRP, including demand-side and supply-side strategies. The scope of our audit included the commencement of the IRP process on October 31, 2013, through the IRP's approval by the TVA Board of Directors on August 21, 2015, and the corresponding Supplemental Environmental Impact Statement (SEIS). We conducted this audit in conjunction with the development of the IRP, periodically providing results of our analysis to TVA management.

### What the OIG Found

We determined TVA's process for developing the 2015 IRP was adequate in considering potential future uncertainties and associated responses. Specifically, we determined the IRP project team:

- Met stakeholder input objectives by engaging numerous stakeholders and incorporating public opinions into the development of the IRP.
- Considered project risks, including those related to project management, and incorporated practices commonly seen in integrated planning processes, as well as best practices, into the IRP.

In our opinion, the IRP team is improving on integrated resource planning efforts as the 2015 IRP incorporated lessons learned from development of the 2011 IRP, where applicable. Additionally, we determined scenario and strategy development and consideration of IRP inputs were consistent with those of other organizations. TVA developed metrics to analyze the portfolios generated in the 2015 IRP that reflected stakeholder input, where applicable, and were consistent with TVA's strategic mission and imperatives. Lastly, we determined considerations included in the SEIS were adequate.

## Executive Summary

There are many considerations in planning for unforeseen events spanning 20 years into the future. In our opinion, TVA's process for developing the 2015 IRP adequately considered alternative scenarios and strategies to develop such a tool. Collaboration with external stakeholders not only enhanced the planning process but also served to educate the public about resource planning at TVA. While all parties in the process did not always agree on decisions made, the collaboration exhibited by internal and external stakeholders was a testament to the dedication of these individuals to aid in the creation of a robust IRP.

# BACKGROUND

The Tennessee Valley Authority (TVA) develops its Integrated Resource Plan (IRP) to guide the organization in meeting future energy demands. The IRP developed by TVA in response to potential industry restructuring, referred to as Energy Vision 2020, was published in December 1995. The stated purpose of this IRP was to be a "roadmap for meeting the energy needs of its customers during the next 25 years with economical and environmentally sound energy choices." TVA cited three factors for producing Energy Vision 2020, including the impact of TVA decisions on stakeholders' quality of life and competitive successes of area businesses and industry, changes in the utility industry such as the concept of open access,[1] and TVA's position in a competitive environment.

Built from the foundation established in Energy Vision 2020, in March 2011, TVA issued a 20-year IRP, referred to as TVA's Environmental and Energy Future. The purpose of the March 2011 IRP was to aid TVA in becoming one of the nation's leading providers of low-cost and cleaner energy by 2020. The recommended planning direction of the 2011 IRP included expansion of energy efficiency and demand response (EEDR), additional pumped-storage capacity, increased contribution of nuclear generation, and utilization of natural gas as an intermediary supply source. Additionally, TVA published an Environmental Impact Statement (EIS) reflecting the potential impacts of the IRP contents on the environment as required by the National Environmental Policy Act (NEPA). The EIS detailed the impact of potential actions resulting from the 2011 IRP on areas such as water quality and land use requirements.

TVA personnel created the 2011 IRP with the intention of developing the scope of the next IRP in 2015. However, according to TVA employees, TVA management decided to update the plan earlier due to significant changes within the electric industry and TVA. These changes included abundant natural gas supplies from shale deposits, a decline in electricity demand growth across the industry and within the Tennessee Valley, a new schedule for completing Watts Bar Nuclear Plant Unit 2, TVA's clean-air commitments,[2] industry changes in areas such as distributed generation and EEDR, and more stringent environmental requirements. In addition to updating the IRP, TVA personnel updated the 2011 EIS and issued the 2015 Supplemental Environmental Impact Statement (SEIS).

[1] Open access was a concept introduced by the National Energy Policy Act of 1992 and the Federal Energy Regulatory Commission. Open access provides wholesale customers and suppliers access to virtually all of the nation's transmission systems.

[2] These commitments included the retirement of less efficient coal capacity by 2019, which resulted from a settlement with the Environmental Protection Agency (EPA), effective June 13, 2011.

## TVA'S 2015 IRP PROCESS

TVA's plans for developing the 2015 IRP contained steps for (1) obtaining internal and external stakeholder input, (2) identifying data to be included as inputs into the plan, (3) modeling the information, and (4) evaluating the modeling results. The IRP planning process is managed by an External Relations Project Manager who leads a team[3] comprised of individuals from TVA's Enterprise Planning, External Relations, Operations, and Environment and Energy Policy organizations. Individuals from these organizations provide input, based on their knowledge and research, into the development of the IRP. Decisions made by this team during the IRP development are also vetted through the Executive Steering Committee, which consists of:

- Vice President (VP), Pricing and Contracts
- VP, Transmission Operations and Power Supply
- Associate General Counsel on Environment, Office of the General Counsel
- VP, Stakeholder Relations
- VP, Government Relations
- VP, Enterprise Planning
- Executive VP and Chief External Relations Officer, External Relations

One external source of information includes public comments obtained during the scoping phase of the IRP and after the issuance of the IRP draft. The objective of the scoping phase is to identify resource options, strategies, and future conditions that merit evaluation in the IRP process. Additional input is obtained from several stakeholder groups whose purpose is to provide input and feedback into the development of the potential futures TVA might face and associated strategies for addressing those futures. External stakeholder groups are also tasked with the responsibility of providing input and feedback on inputs to be included in the modeling of potential futures and associated strategies and the development of metrics used to evaluate modeling results. TVA also planned to utilize various consultants to help manage and evaluate development of the IRP.

The first step of the IRP process, after obtaining public scoping comments, is the development of study inputs and framework. The project team utilizes the strategic power supply plan (PSP), referred to in this IRP as the "Current Outlook," as the starting point for development of inputs. Using the information gathered from internal and external sources, the IRP team develops the scenarios and strategies that will be part of the IRP framework. The goal in developing a broad set of strategies and scenarios, as stated by TVA, is to "identify an energy resource plan that performs well under a variety of future conditions (e.g., a strong economy or a weak economy) thereby reducing the risk

[3] The team is also divided into subgroups, such as scenario, strategy, modeling, and metric teams.

that a selected strategy or plan would perform well under one set of future conditions, but poorly under a different set of conditions." Scenarios are plausible futures involving trends and/or factors (uncertainties)[4] over which TVA has no control. An example of a scenario would be a future in which rapid economic growth translates into higher than forecasted energy sales and resource expansion. These plausible futures are possible conditions, not future predictions, which should demonstrate adequate diversity among significant uncertainties.[5] Uncertainties usually fall within a reasonable, but possibly wide range, bounded by high and low industry projections. Valid scenario development requires participation by individuals from various disciplines, including some outside the utility field.

Strategies, on the other hand, are approaches to addressing capacity needs and reflect demand and supply attributes[6] over which TVA has control. An example of a strategy would be the use of electricity-generating resources that meet lower emissions targets. Attributes can be incorporated into the planning process as (1) TVA-defined timing, quantity, or constraint[7] values and/or (2) variables with values determined by optimization modeling software. The IRP team develops inputs such as generating resource data, including capital, operating and maintenance (O&M) as well as fuel costs, capacity amounts, operating characteristics, and purchased power prices for supply-side and demand-side options. The team also develops other planning information, including financial parameters and forecasts.

TVA uses the PI Plus model, a Regional Economic Models, Incorporated product,[8] to perform macro-economic modeling using inputs such as coal, gas, and oil prices; electricity prices; energy efficiency (EE) load information; and distributed generation and renewables load information. A part of the process for TVA is developing forecasts for economic data, including gross domestic product, nonfarm employment, customer count, system load, and energy demand. In addition, TVA utilizes other forecasting tools to generate commodity forecasts for the IRP. This information, along with the strategies and attributes, scenarios, and related uncertainties, serves as inputs into an optimization model, which creates portfolios referred to as capacity expansion plans, for each strategy/scenario combination.

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4 Uncertainties are volatile, could significantly impact operations, and include commodity prices, environmental regulations, EEDR, and distributed generation potential.

5 To address scenario diversity, TVA personnel evaluated the three uncertainties considered most likely to influence the resource plan: TVA sales, natural gas prices, and cost of carbon dioxide ($CO_2$) regulation compliance.

6 Attributes are a combination of resource assumptions, such as nuclear expansion, EEDR commitment, renewable resources, fleet reduction, market reliance, and/or energy storage.

7 Constraints may include minimum construction times, time requirements for transmission upgrades, fuel supply route and infrastructure limitations, and reliability (reserve margin) requirements.

8 PI Plus is used to model “the multiplier effects of each strategy’s expenditures that stimulate the regional economy and its electric bills.” TVA’s model has been tailored to the TVA region by county and optimized to capture the interindustry and interregional linkages with surrounding counties and the rest of the United States (U.S.).

The generation of portfolios is a two-step process containing development of optimized capacity expansion plans using System Optimizer[9] and then creation of a detailed financial analysis using MIDAS.[10] TVA uses stochastic[11] analysis within MIDAS to make sure a sufficient data range is considered. This software also utilizes Latin Hypercube sampling[12] to create parameters for each data input by calculating volatility, means revision rate, and distribution. Parameters are used to define various magnitudes from which MIDAS makes random selections to fill distribution curves. In addition, MIDAS generates financial information for each capacity expansion plan for each month and year within the 30-year period. The model optimizes the resource mix within each portfolio to minimize the present value of revenue requirements (PVRR) subject to constraints. TVA personnel then perform sensitivity analyses that represent probability studies around critical uncertainties and/or planning assumptions.[13] This allows variation in inputs over time in order to better simulate future uncertainty and evaluate risks.

The IRP team also develops various metrics to assess and compare the performance of planning strategies in each scenario. The metrics are designed to reflect quantitative and qualitative differences among the strategies. They typically include cost and risk factors and other indicators such as environmental, flexibility, and economic impacts that reflect important aspects of TVA's mission and its goals and priorities. After these steps have been developed and feedback from internal and external sources has been incorporated into the IRP, the IRP team identifies a preferred power supply mix. This information is presented to the TVA Board of Directors for approval.

TVA's current IRP was issued in draft March 2015 and unanimously approved by the TVA Board on August 21, 2015.[14] TVA personnel considers the 2015 IRP a comprehensive study of how TVA might meet future energy and capacity needs beyond what can be met with existing energy resources in a variety of future environments. The goal of the IRP is to balance the objectives of TVA's overall mission while ensuring a diversified electricity generation mix.

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9 System Optimizer is a capacity optimization model that uses a simplified dispatch algorithm to compute production costs and a "representative hours" approach in which average generation and load values in each representative period within a week are scaled up appropriately to span all hours of the week and days of the months.

10 MIDAS is a strategic planning software tool that uses a chronological production costing algorithm with financial planning data to assess plan cost, system rate impacts, and financial risk.

11 Stochastic analysis is a sophisticated analytical technique that allows for risk analysis by varying important drivers in multiple runs to create a distribution of total costs rather than a single point estimate.

12 Latin Hypercube sampling is a statistical method for ensuring each probability distribution in the model is evenly sampled.

13 Critical uncertainties and assumptions include commodity prices, load shapes, electricity demand, and plant availability.

14 TVA personnel planned to present the 2015 IRP to the TVA Board in May 2015; however, presentation was delayed until August 21, 2015.

# OBJECTIVE, SCOPE, AND METHODOLOGY

We evaluated the adequacy of TVA's development process for the 2015 IRP, including demand-side and supply-side strategies. The scope of our audit included the commencement of the IRP process on October 31, 2013, through the IRP's approval by the TVA Board on August 21, 2015, and the corresponding SEIS. We conducted this audit in conjunction with the development of the IRP, periodically providing results of our analysis to TVA management.

To evaluate the adequacy of the development process, we attended IRP team meetings and meetings with external stakeholders to observe the vetting of decisions made in the development of the IRP. We also compared IRP inputs to authoritative industry sources, such as the Energy Information Administration (EIA),[15] and assessed benchmarking information provided by ScottMadden management consultants. At specific milestones within the IRP, we provided the analysis of those observations to TVA so recommendations could be implemented throughout the process. We obtained an understanding of internal controls related to our audit objective but did not perform testing of controls. See Appendix A for more detail on the objective, scope, and methodology.

# OBSERVATIONS

Based on our observations and work performed, we determined TVA's process for developing the 2015 IRP was adequate in considering potential future uncertainties and associated responses. Specifically, we determined the IRP project team:

- Met stakeholder input objectives by engaging numerous stakeholders and incorporating public opinions into the development of the IRP.
- Considered project risks, including those related to project management, and incorporated practices commonly seen in integrated planning processes as well as best practices into the IRP.

In our opinion, the IRP team is improving on integrated resource planning efforts as lessons learned from the development of the 2011 IRP were incorporated into the 2015 IRP. Additionally, we determined scenario and strategy development and consideration of IRP inputs were consistent with those of other organizations. Our assessment of actions taken to develop the IRP and SEIS found that actions were adequate.

[15] The EIA is part of the U.S. Department of Energy and is responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.

## INTERNAL AND EXTERNAL STAKEHOLDER INPUT

Two of the IRP public involvement goals were to (1) engage numerous stakeholders with differing viewpoints throughout the process and (2) incorporate public opinion into the development of the IRP. We obtained process design documentation from the IRP Project Manager detailing the plan for obtaining input and feedback from both internal and external stakeholders. The process was designed to obtain public comments prior to development of the IRP and after the draft IRP was issued. The process design also allowed for creation of internal and external teams whose responsibilities were to offer input and provide feedback into the IRP development. Based on observations of internal and external stakeholder meetings, we confirmed both internal and external stakeholder input and feedback were obtained and considered by the IRP team. We also confirmed TVA engaged with elected officials; customers, including local power companies and direct serve customers; and the TVA Board as part of the IRP development.

### Internal Stakeholder Input

To obtain internal stakeholder feedback, an IRP Executive Steering Committee and IRP internal teams were established to assist with vetting decisions and results. IRP internal teams included core, strategy, scenario, modeling, metric, document, and NEPA teams. The core team, consisting of the project team and key leaders from other TVA groups directly involved in the study, was initiated to manage the project. The scenario and strategy teams were cross-disciplinary teams comprised to develop scenarios and strategies for the IRP. Translation of scenario definitions into modeling parameters was the responsibility of the modeling team. This team included Enterprise Planning personnel responsible for developing modeling approaches and defining constraints for key assumptions. The metric team was initiated to develop metrics used to analyze the modeling results. The document team prepared IRP documentation, including the draft and final IRP, while development of the SEIS was the responsibility of the NEPA team. The IRP project team planned to keep the TVA Board informed of IRP decisions at TVA Board meetings and throughout the IRP process.

To determine whether the IRP project team obtained internal stakeholder input, we interviewed internal stakeholders, including those who (1) participated on IRP project teams, (2) served as Executive Steering Committee members or sponsors, and (3) represented strategic business units. We also observed the exchange of information between internal stakeholders by attending select scenario, strategy, modeling, and metric team meetings. These meetings contained discussions of internal and external stakeholder feedback used to develop and refine the IRP.

Early in our review, we noted the IRP team did not obtain input from TVA's Enterprise Risk Management (ERM) organization. The ERM organization evaluates and reports risks facing TVA with the goal of bringing awareness to

enterprise-wide risks. Specifically, its mission is to provide TVA with a comprehensive perspective to more effectively identify and manage risks, capitalize on opportunities, and improve risk management behaviors at TVA. We discussed the importance of including this organization with the IRP Project Manager who agreed adding the ERM organization was a process enhancement. We observed ERM staff attended subsequent Integrated Resource Plan Working Group (IRPWG) meetings.

Throughout the IRP development, TVA staff kept the TVA Board informed on the process including significant developments. This included regular updates at External Relations Committee meetings, updates on key IRP milestones at TVA Board meetings, and answers to specific TVA Board questions. The updates included information on IRP-specific events, such as the EE seminar (as discussed on page 8), copies of TVA-developed press releases on the IRP, and the draft and final IRPs.

**External Stakeholder Input**

To obtain external stakeholder input, TVA established various stakeholder groups including the IRPWG, Energy Efficiency Information Exchange (EEIX), and the Tennessee Valley Renewable Information Exchange (TVRIX). The IRPWG was comprised of various representatives from institutions, such as the Kentucky Energy and Environment Cabinet, Partnership for Affordable Clean Energy, and various Chambers of Commerce. This group served as one of the external stakeholder groups who assisted with the vetting of scenarios, strategies, modeling, and metrics used to develop the IRP. The responsibility of the EEIX was to assist TVA with identifying EE best practices for consideration in the IRP. The EEIX was comprised of individuals representing state energy offices, nongovernment organizations, local power companies, and the Tennessee Valley Public Power Association. In conjunction, the TVRIX was tasked with the responsibility of providing TVA input on renewable options in the Tennessee Valley. Composition of this group included expertise from renewable energy interest groups, state government, and utilities.

In April 2013, the TVA Board formed a federal advisory committee, the Regional Energy Resource Council (RERC), for the purpose of providing advice on energy resource activities and priorities among competing objectives to the TVA Board and staff. The RERC is comprised of 20 members representing a broad range of views and interests, including environmental, industrial, business, consumer, educational, and community leadership interests. As part of their responsibility, the RERC was tasked with providing input into the IRP. TVA also developed plans for engaging with the public and elected officials. These included conducting public scoping sessions, quarterly briefings, and meetings with elected officials, when warranted.

<u>Input From TVA External Stakeholder Groups</u>

We attended select meetings with external stakeholders to determine whether input and feedback provided as part of the IRP process were incorporated, as

applicable. Specifically, we observed meetings between the project team and IRPWG members containing discussion of input assumptions and IRP preliminary results. We also observed select EEIX and TVRIX meetings and obtained documentation from meeting discussions. These meetings contained input on renewables and EE, respectively, which served as a basis for the EE and renewables modeling.

Because of external stakeholder concerns regarding the amount of EE to be included in the 2015 IRP, TVA held a seminar in February 2015 at the Howard Baker Center on the campus of the University of Tennessee, Knoxville. The seminar provided detailed information on the EE modeling methodology and included EE presentations from stakeholders, ScottMadden EE benchmarking methodology, Navigant Consulting EE modeling presentations, and an EE-focused question and answer session with stakeholders. We also attended the TVA roundtable discussion hosted by U.S. Senators Lamar Alexander and Robert "Bob" Corker in May 2015, where TVA discussed its long-term power strategy, which included the IRP. Additionally, we noted three of TVA's key external stakeholders, the Tennessee Valley Public Power Association, Seven States Power Corporation, and the Tennessee Valley Industrial Committee, endorsed the IRP process during the August TVA Board meeting.

Input From the RERC

As part of their role in the review of the IRP, RERC members participated in a joint public session with the TVA Board where panel discussions were held on renewables, EE, and the utility landscape. A public listening session was also part of the agenda. By attending this, and other RERC meetings, we confirmed RERC member comments were considered in the IRP development, where applicable. We also reviewed feedback from RERC members concerning the IRP development process. Members of the RERC developed a statement read by the RERC Chairman at the August 2015 TVA Board meeting. The statement affirmed the 2015 IRP (1) identified resource solutions to allow TVA to provide reliable service and meet objectives of the study, (2) provided flexibility, (3) used innovative modeling practices, (4) made strides in improving the environmental profile and $CO_2$ emissions, and (5) involved multiple opportunities for public review and comment.

Input From the Public and Elected Officials

In our opinion, TVA engaged extensively with the public during the IRP and SEIS development processes. To begin the 2015 IRP process, TVA filed a Notice of Intent in the Federal Register on October 31, 2013, opening the scoping period for the IRP, which ended November 22, 2013. As this was a supplementary EIS issuance, a public scoping period was not required; however, TVA decided to conduct a public scoping period to increase public involvement in the process. TVA issued a news release informing the public about IRP public scoping sessions, and TVA hosted two public scoping sessions that included webinars in October 2013 and November 2013. As part of the public scoping process, TVA accepted written comments through various methods including mail, e-mail, and

fax. After comments were obtained, TVA published a report in June 2014 introducing the IRP and programmatic EIS processes. This report included the assembly of the 1,156 comments obtained during the public scoping session. We attended both sessions and reviewed comments related to energy resources (e.g., coal, nuclear, wind) and the IRP analysis process.

As the IRP and SEIS were developed, TVA held three public update sessions in March, June, and November 2014 that were also available via webinar. We attended these sessions and determined each included a presentation on the progress of the IRP and SEIS as well as a moderated question and answer session. On March 13, 2015, a Notice of Availability was published in the Federal Register announcing the draft SEIS and initiating the public comment period ending April 27, 2015. During this time period, TVA hosted seven public sessions in locations across the Tennessee Valley. At these sessions, TVA presented an overview of both the draft IRP and SEIS and held a moderated question and answer session with a panel of TVA subject matter experts. TVA also accepted written comments through various methods including mail, e-mail, and fax.

As part of the final SEIS, TVA produced a document titled "2015 Final Supplemental Environmental Impact Statement Volume 2 – Responses to Comments on the Draft EIS." TVA received about 200 comment submissions signed by more than 2,400 individuals, which TVA staff synthesized into about 180 statements. TVA provided responses to these comments by category. Categories included editorial comments, energy resource options, environmental impacts, greenhouse gas emissions, integrated resource planning, and NEPA compliance/adequacy. TVA's responses included answers to questions and, where appropriate, revisions to the final IRP. As part of the process and in conjunction with stakeholder feedback, TVA ran sensitivities paralleling areas where stakeholders had questions between the draft and final IRP.

We interviewed the IRP Project Manager and determined that TVA also engaged with elected officials throughout the IRP process. According to the IRP Project Manager, engagement included (1) Government Relations and External Relations staff informally updating various groups in state governments, (2) TVA management briefing of congressional staffers on the final IRP, (3) Customer Delivery staff informally keeping local government and distributors informed on the process, and (4) the NEPA Compliance Specialist informally updating the EPA. We did not obtain documentation of nor observe these meetings; however, we noted local officials had representation on the external stakeholder groups and RERC.

In our opinion, TVA had a high level of internal and external stakeholder engagement in the IRP and SEIS development processes. TVA illustrated this commitment to stakeholder engagement by providing multiple opportunities for input from stakeholders, considering various viewpoints throughout both processes, and providing responses to stakeholder questions and challenges.

Stakeholders involved in the process recognized this in a comment to the March 2015 draft IRP document that stated:

> We applaud TVA for its commitment to extensive stakeholder involvement throughout the development of the IRP. These efforts have included public meetings, the IRP Working Group, the renewables and energy efficiency information exchanges, and the Regional Energy Resource Council. As a result of this, TVA has set a new standard for other utilities.

TVA staff and the TVA Board recognized the value of stakeholder engagement and plan to continue engagement during implementation of the IRP. In our opinion, stakeholder engagement in the IRP and SEIS development processes increased buy-in into the final products and endorsed a shared vision for the mission of TVA going forward.

## IRP RISK ANALYSIS

There are two types of risks associated with the development of the IRP. These include risks inherent in project management, such as scheduling and budget risks, and process risks to be considered as part of the integrated resource planning process, which includes assessment of the internal and external environment to identify potential future uncertainties. We determined there was no formal documentation of project management risks; however, IRP project management considered these risks and mitigations. Additionally, we determined incorporation of process risk into the IRP was adequate.

### IRP Project Management Risks

While there was no formal project risk documentation, various project risks were identified by the Project Manager and team, including an aggressive schedule, risk of exceeding the budget, effects of organizational changes, and risks related to the unpredictable nature of the project. The Project Manager discussed other risks, including limited accommodations in the software for modeling certain resources, doubtful ability to evaluate impact of alternatives to real-time operations, and difficulty obtaining cost and performance characteristics for all resources. According to the IRP Project Manager, the project team relied on system controls within Enterprise Planning processes. Regarding controls over the data included in the development of the IRP, the project team utilized a central data-sharing product as well as e-mail to house and share information related to the IRP.

While the IRP project team planned to present the draft IRP to the TVA Board in May 2015, it was necessary to make adjustments to the schedule. One reason for the adjustment was that Enterprise Planning had to determine a methodology for modeling EE as a resource as that had not been done in the 2011 IRP. According to the IRP Project Manager, actions taken to minimize schedule adjustments included building contingency in the schedule; focusing on milestone

dates; having an aggressive, frequent briefing cycle with the executive team; and prioritizing IRP activities ahead of other job duties. These actions enabled the team to present the IRP to the TVA Board at the August 2015 meeting. Additionally, the Project Manager tracked the IRP budget, which included a contingency to minimize the risk of exceeding the budget. To minimize the impacts of organizational changes and the unpredictable nature of the project, the IRP team members were in frequent dialogue with each other and external stakeholders. According to the Project Manager, in addition to stakeholder team meetings, project team members met periodically with some external stakeholders to discuss questions or comments.

Other risks related to the project included:

- Potential Limits Within the Modeling Software – Because Enterprise Planning has not modeled EE as a resource in past IRPs, the organization had to determine a methodology for using current tools to develop an approach for modeling this resource in the 2015 IRP. According to the IRP Project Manager, Enterprise Planning personnel plan to perform a software review to identify enhanced modeling tools for use in the development of future IRPs.
- Inability to Evaluate Impact of Alternatives – To minimize the risk pertaining to evaluating the impact of alternatives, the IRP project team developed a flexibility metric that evaluates the type and quantity of resources and the extent to which the mix can follow load swings. This metric was developed to measure the responsiveness of the generation portfolio. While this metric was considered to be an acceptable risk mitigation for the 2015 IRP, project management stated the Enterprise Planning and Operations Planning organizations are discussing enhancements to the flexibility metric for future IRPs.
- Difficulty in Obtaining Cost and Performance Characteristics for All Resources – We observed cross-functional modeling team meetings, which included provision of cost and performance characteristics as inputs into IRP modeling. We consider these and other internal IRP-related meetings as adequate mitigations for timely receipt of cost and performance characteristics and organizational changes.

**IRP Process Risks**

As indicated previously, integrated resource planning inherently contains risks and uncertainties due in part to not being able to accurately predict the future. We assessed the planning process to determine whether the IRP project team adequately included consideration of internal and external risks. To determine whether internal risks were considered, we interviewed personnel within TVA's Operations, Enterprise Planning, and ERM organizations. We determined individuals within TVA Operations and Enterprise Planning had input into the risks incorporated into the IRP. However, ERM had not been contacted for input until we discussed this issue with the IRP Project Manager.

To determine whether external risks were considered, we (1) examined TVA risk documentation, (2) reviewed a prior Government Accountability Office (GAO) report[16] on TVA's previous resource planning efforts, (3) discussed resource planning risks with GAO, and (4) compared IRP risk considerations to EIA Annual Energy Outlook (AEO) documentation. We examined TVA-identified risks related to minimal load growth from the second and fourth quarter 2013 organizational risk maps for comparison with IRP framework elements. We determined that high-level risks within the organizational risk maps, including (1) load, revenue, and financial forecasting; (2) power delivery; (3) loss of customer load; (4) global economic conditions that impact industrial recruitment as well as existing customer base; (5) game changing commodity technology; and (6) the ability to respond timely to competitive threats were considered in strategy and scenario planning or modeling of the IRP.

Additionally, we reviewed the GAO's 2011 report on TVA's resource planning efforts and discussed with GAO personnel the risks identified as part of its review. These risks included anticipated environmental regulations, EE program considerations, and reporting of energy savings. These risks were addressed in the 2015 IRP scenario and strategy planning. We also reviewed the U.S. EIA 2013 AEO, [17] EIA's AEO 2014 Early Release Overview, and other EIA supporting information to identify any potential risks for consideration in the IRP. We determined the IRP project team considered specific risks mentioned in EIA's 2013 AEO in scenario and strategy planning. Table 1 contains a list of the EIA risks and associated risk considerations compared to EIA.

| EIA Risks | IRP Risk Consideration |
|---|---|
| • Changes in air pollution regulations:<br>– Recent ruling on Cross-State Air Pollution Rule and the Clean Air Interstate Rule including Mercury and Air Toxic Standards.<br>– Boiler Maximum Achievable Control Technology regulations.<br>• Greenhouse gas emissions.<br>– Regional Greenhouse Gas Initiative. | • Regulation uncertainty described as regulatory and legislative actions, including applicable codes and standards that impact the operation of electric utilities excluding $CO_2$ regulations.<br>• Stringent environmental regulations lead to weak energy sales within the scenarios.<br>• Environmental Outlook Document.<br>• Included in the Current Outlook. |
| • State-specific renewable portfolio standards to which North Carolina is subject. | • TVA is not subject to these requirements; however, renewables were considered within the strategies. |
| • Risks of maintenance requirements and costs for combined cycle units. | • Gas price uncertainty described as the price ($/MMBtu)[18] of the commodity including transportation.<br>• Natural gas within the strategies.<br>• Resource sensitivity cases. |

[16] GAO Report, "Full Consideration of Energy Efficiency and Better Capital Planning Expenditures are Needed," issued October 2011.

[17] EIA's AEO contains future projections and analysis of U.S. energy supply, energy disposition, and environmental information through 2040.

[18] MMBTu represents 1 million British Thermal Units; a measurement for natural gas.

| | |
|---|---|
| • Nuclear risks including:<br>– Nuclear Regulatory Commission's (NRC) Waste Confidence ruling.<br>– NRC approval of nuclear uprate projects.<br>– O&M costs and capital expenditures of license renewals beyond 60 years.<br>– NRC requirements for Fukushima. | • Existing nuclear and nuclear additional attributes discussed within strategies.<br>• Nuclear sensitivity cases. |
| • Uncertainties regarding small modular reactors. | • Nuclear additions within strategies.<br>• Small modular reactor sensitivity case. |

**Table 1**

## IRP FRAMEWORK

To evaluate the adequacy of the 2015 IRP framework development, we compared TVA's integrated resource planning process to practices common to IRP development and IRP best practices and determined whether 2011 IRP lessons learned were incorporated, where applicable. We also assessed input included in the development of IRP strategies and scenarios and concluded that development of the IRP framework was adequate.

### Best Practices and 2011 IRP Lessons Learned

We identified best practices for integrated resource planning processes, including information prepared for the U.S. Agency for International Development by the Tellus Institute[19] and data from Synapse Energy Economics.[20] Because best practice information for IRP development was limited, we also identified common[21] elements expected in IRP development from various sources. Descriptions of these criteria are included in Appendix A. Based on our comparison of TVA's 2015 IRP process to identified common elements and best practices, we determined TVA incorporated all identified practices. Appendix B contains details of the comparison. In some cases, TVA instituted practices not included in the common or best practice information. These actions include the performance of a benchmarking review and the inclusion of a third-party review of information.

In addition, we reviewed lessons learned documentation from the 2011 IRP and determined actions were taken in the current IRP to address the lessons learned, where applicable. Lessons learned from the 2011 IRP included elements such as creating separate documents for the IRP and SEIS and assignment of an executive sponsor to oversee the IRP project. According to the IRP Project Manager, as of August 2015, the IRP project team was in the process of formalizing documentation of lessons learned from the 2015 IRP development process.

[19] Tellus Institute is a nonprofit research and policy organization based in Boston, Massachusetts.

[20] Synapse Energy Economics is a research and consulting firm specializing in energy, economic, and environmental topics.

[21] We considered a practice to be "common" if cited by two or more information sources.

## SCENARIO AND STRATEGY DEVELOPMENT

TVA utilized the fiscal year 2015 strategic PSP as the Current Outlook, a starting point for development of scenarios and strategies. TVA also utilized internal and external stakeholder input and industry information to develop scenarios and strategies. TVA's final IRP included five scenarios and five strategies, which comprised 25 portfolios, intended to represent a multiyear energy resource plan for meeting future power needs.

We evaluated the IRP scenarios and associated uncertainties and strategies, including related attributes for reasonableness by observing meetings between internal and external stakeholders, comparing information to the 2013 and 2014 EIA AEO cases, and reviewing benchmarking information obtained by ScottMadden on behalf of TVA. Both scenarios and related uncertainties as well as strategies and associated attributes were considered reasonable.

### Scenario Development

As stated previously, we observed IRP project team meetings with external stakeholders. These discussions involved the development of nine scenarios that were narrowed to five, including the Current Outlook, by the IRP project team and IRPWG. In addition to the Current Outlook, TVA scenarios included a growth economy, stagnant economy, decarbonized future, and distributed marketplace. We also observed discussions surrounding development of the nine uncertainties included in each of the scenarios, which consisted of (1) sales, (2) natural gas prices, (3) wholesale electricity prices, (4) coal prices, (5) regulations, (6) $CO_2$ regulations and price, (7) distributed generation, (8) EE adoption, and (9) economic outlook. Stakeholder input was considered by the IRP project team, where applicable.

Because the EIA gathers statistics and analyzes the U.S. energy supply, energy disposition, and environmental information as well as makes future projections based on these analyses, we compared TVA-developed scenarios to the 2013 and 2014 EIA AEO cases (i.e., scenarios) and determined that scenarios were generally consistent with those modeled by EIA.[22] Additionally, we compared the gross domestic product data, nonfarm employment rates, consumer price index, and gas and coal prices to 2013 and 2014 EIA AEOs, where applicable. We determined ranges developed by TVA were generally consistent with those developed by EIA. We confirmed the $CO_2$ prices, demand, load, and on-peak power prices used as the basis for modeling uncertainties agreed with those values included in the 2015 strategic PSP. We also confirmed $CO_2$ prices were set at the U.S. government's social cost of carbon. The social cost of carbon is an estimate of the economic damages associated with a small increase in $CO_2$ emissions, conventionally one metric ton, in a given year. This measure is used by the EPA and other federal agencies to estimate the climate benefits of rulemaking.

[22] EIA modeled additional scenarios, such as high and low imports, not applicable to TVA.

We reviewed benchmarking data provided by ScottMadden that compared TVA's scenario and uncertainty development to eight other utilities. According to ScottMadden, TVA's scenarios were generally consistent with those of other utilities. Specifically, most utilities included scenarios built around $CO_2$ compliance costs and natural gas prices as did TVA. Additionally, ScottMadden determined a number of the utilities benchmarked were modeling six of the nine uncertainties included in the 2015 IRP. For variances between TVA and other utilities, we reviewed explanations and determined they were reasonable. For example, a scenario considered by other utilities was demand-side management achievement. The IRP project team did not specifically include this as an uncertainty; however, it was considered as part of the EE adoption uncertainty.

**Strategy Development**

We observed discussions between the IRP project team and external stakeholders involving the development of strategies and associated attributes. These discussions involved the development of eight alternate strategies that were narrowed to five by the IRPWG and the IRP project team, including the traditional least-cost optimization currently used by TVA. In addition to the least-cost optimization strategy, TVA strategies were defined as meeting an emission target, focusing on long-term market supplied resources, and maximizing EE and renewable resources. Stakeholder input was considered by the IRP project team, where applicable.

We compared TVA-developed strategies and attributes to the 2013 and 2014 EIA AEO cases. TVA attributes included existing nuclear, nuclear additions, existing coal, new coal, gas additions, EEDR, renewables, purchased power agreements, distributed generation/distributed energy resources, and transmission. We determined strategy attributes were generally consistent with those modeled within 2013 and 2014 EIA AEO cases.

We also reviewed benchmarking data provided by ScottMadden that compared TVA's strategy and attribute development to eight other utilities. ScottMadden reported that, on average, other utilities evaluate three to four strategies. TVA's approach is consistent with this method because it narrowed the list of strategies down to five, including the traditional least-cost optimization currently used by TVA. For variances between 2015 IRP strategies and those of other utilities, we reviewed explanations and determined that explanations were reasonable. For example, ScottMadden reported one utility had a strategy focusing specifically on nuclear. While the IRP team TVA did not have a strategy focusing on nuclear, nuclear was considered as an element of another strategy. TVA also performed sensitivity analyses on nuclear additions.

## IRP INPUTS FOR MODELING

In conjunction with evaluation of data inputs related to scenarios and strategies, we assessed inputs related to key supply-side and demand-side options to determine whether data was reasonable and up-to-date. We reviewed

benchmarking data related to modeling provided by ScottMadden. We also observed modeling input discussions and compared IRP inputs to other industry information.

A key piece of the 2015 IRP input process was the work Navigant Consulting performed on behalf of TVA in validating EE and modeling inputs; therefore, we reviewed Navigant's correspondence to TVA validating IRP inputs. In addition, we evaluated whether TVA adequately considered transmission limits in the IRP analysis. We met with Enterprise Planning personnel for demonstrations of systems used in the modeling and forecasting processes. Based on our analysis, we concluded IRP inputs for modeling were adequate.

**Benchmarking**

We reviewed ScottMadden's benchmarking information and noted TVA compared favorably to other utilities in terms of screening of generation alternatives as well as modeling and evaluation. TVA considered all resource categories (i.e., coal-fired, gas-fired, nuclear, renewables, and storage) and most individual resource types[23] (e.g., small modular reactor, biomass, hydroelectric) considered by other utilities. TVA's modeling approach and scorecard were also in line with benchmarked utilities. We identified no differences requiring further explanation. ScottMadden also presented information on common industry trends among the benchmarked utilities as described in Table 2. We found TVA considered these trends in development of the IRP.

| Common Industry Trends | |
|---|---|
| **Demand Growth** | • The 2013 EIA AEO expects electricity demand to increase 0.90% year over year from 2013 through 2040.[24] Assumptions modeled by utilities range from 0.80% to 2.40% and averaged 1.70%. |
| **Capacity Expansion Plans** | • Planned additions are predominately natural gas.<br>• Only three utilities had nuclear additions.<br>• No IRP included coal or hydroelectric additions. |
| **Retirements and Conversions** | • All IRPs included retirement of some coal generation.<br>• Half of utilities benchmarked plan to convert some coal generation to natural gas. |
| **Renewables** | • Levels are mainly driven by renewable energy portfolio standard requirements (which do not apply to TVA) and incentive program expectations.<br>• Majority of renewable additions will be solar. |

[23] In the final IRP, TVA stated for consideration resource options must: (1) use a proven technology, or one that has a reasonable prospect of becoming commercially available in the planning horizon, and (2) be available to TVA within the region or through market purchases.

[24] We confirmed this data through review of the 2013 EIA AEO.

| | |
|---|---|
| | • Four of the eight benchmarked utilities did not anticipate adding any new company-owned renewable generation during the planning period. |
| **EE and Demand-Side Management** | • Utilities are placing a significant emphasis on EE and demand-side management in IRPs.<br>• In most cases, EE levels are driven by regulatory requirements. |
| **Public Comments** | • Commenters are pushing for greater levels of EE, demand-side management, and renewables.<br>• IRPs are subject to increasing levels of public scrutiny. |

**Table 2**

## Supply-Side and Demand-Side Options

TVA considered a range of traditional energy resource options, including nuclear, coal, natural gas, hydroelectric, petroleum fuels, energy storage, wind, solar, biomass, EE, and demand response. In addition, TVA considered new resources such as small modular reactors, compressed air energy storage, and high-voltage direct current (HVDC)[25] wind. Where applicable, for each resource option considered, TVA developed cost characteristics, which included (1) unit capital costs, (2) capital escalation rates, (3) construction spend schedules, (4) fixed O&M costs, (5) variable O&M costs, and (6) fuel expense and transmission costs for new generation resources. The IRP team also developed operating characteristics for each resource option, where applicable. These included summer net dependable capacity,[26] capacity credit,[27] summer full load heat rate,[28] unit availability, and the number of years a resource is expected to be in service for accounting purposes. Consideration of these items was consistent with TVA's 2015 strategic PSP, which is used as the Current Outlook.

TVA also considered the impact of increased EE, renewables and distributed generation within scenarios, strategies, and modeling. The 2011 IRP modeled EE after existing TVA program designs, but the project team took a different approach in the 2015 IRP by modeling EE as a resource through development of "blocks" of EE that "reflect the characteristics of existing programs but do not require the development of detailed program designs." The goal of this approach was intended to give the model the opportunity to select the optimum level of EE for each portfolio generated as opposed to being provided discrete EE portfolios to match specific strategies. The IRP project team and EEIX stakeholders collaborated to develop inputs, such as regional adoption rates, for EE.

[25] HVDC is considered a highly efficient alternative for transmitting large amounts of electricity over long distances and for special purpose applications.

[26] Summer net dependable capacity is the amount of generating capacity available to the system after accounting for internal uses.

[27] The capacity credit is the amount of capacity immediately available at the highest demand times.

[28] Heat rates are measurements of the consumption of fuel necessary for a unit to produce electricity.

TVA accounted for distributed generation specifically in each scenario by applying $CO_2$ uncertainty to the national renewable energy adoption rate and from those deriving national levels of distributed generation growth. The national levels of distributed generation growth were then scaled down to reflect regional distributed generation growth in the Tennessee Valley region. To model wind and solar, TVA had to determine the effect of energy profiles and net dependable capacity values. The IRP project team and TVRIX stakeholders collaborated to develop inputs for renewable resources, such as solar.

We compared IRP inputs related to EE and renewable resources with information from the American Council for an Energy-Efficient Economy and information included in the EEIX and TVRIX meetings and found no exceptions. Specifically, we determined the IRP project team considered EE regulations, incentives, appliance standards and building codes, retrofits,[29] combined heat and power,[30] and renewable resources, including wind and solar, where applicable. We also compared demand-side and/or supply-side strategy components identified by (1) U.S. EIA, (2) Electric Power Research Institute, (3) Edison Electric Institute data, (4) American Public Power Association (APPA), (5) North American Reliability Corporation (NERC), and (6) Nuclear Energy Institute to the 2015 IRP. We determined TVA, if applicable, either directly or indirectly through scenarios, uncertainties, strategies, or sensitivities considered these components. We also observed modeling team meetings where IRP project teams considered and incorporated stakeholder input, as appropriate.

**Navigant Consulting Conclusions**

We reviewed Navigant Consulting's report and corresponding information regarding the inputs into TVA's 2015 IRP. TVA used Navigant to review EE assumptions and related system modeling approach for the IRP. Based on the review of the data, Navigant concluded the following:

> TVA appears to be relatively well positioned to take the innovative step of introducing EE into the IRP capacity expansion model as a model-selectable resource, rather than forcing it in pre-set amounts at pre-set times. Since this has not be [sic] attempted previously at TVA, it is not surprising that the approach and results rely heavily on methods and assumptions that are not yet fully validated.

Navigant provided recommendations to help solidify TVA's approach; however, the consultant noted most of the recommendations would require more time than was available to TVA in the current IRP cycle. Navigant recommended that TVA should, in the interim, continue to explore and communicate the impact of critical assumptions of EE selection and performance in the modeling suite. Navigant also concluded TVA is striving to fairly represent all potential new generating

[29] Retrofits are defined as actions involving the replacement of existing features or equipment with similar features or equipment that provide the same or better service along with improved EE.

[30] The EPA defines combined heat and power as an efficient and clean approach to generating electric power and useful thermal energy from a single fuel source.

resources in its IRP modeling, thus laying the basis for meaningful IRP modeling of resource expansion alternatives.

**Transmission Inputs**
NERC outlines the importance of focusing on transmission and the effects of a changing utility on transmission infrastructure in its analysis of the future of the industry. We determined the IRP project team included transmission attributes in each strategy. In addition, Navigant Consulting assisted TVA in determining whether it would be beneficial to model transmission as a resource. As part of this effort, economic studies were developed for two transmission lines in different TVA service regions to determine if there was a cost-benefit to modeling these as inputs. The study concluded the impacts of both cases, relative to the base case, were relatively modest. Both of the cases contributed to regional flexibility in meeting power demand with modest changes in dispatch/generation and net exports/ imports. Additionally, TVA was involved with another industry study advocated by NERC, outside of the IRP, which compared probabilistic and deterministic [31] transmission planning. According to the IRP Project Manager, the results of both studies were conflicting and, while TVA anticipates exploring this option in the future, the decision was made to not add this to the 2015 IRP. In our opinion, this approach is reasonable and TVA adequately considered transmission limits in the IRP analysis.

**System Observations**
We conducted observations of various systems utilized by TVA to model the IRP data inputs. Specifically, after modeling inputs are developed, TVA generates resource plan portfolios for each strategy and scenario resulting in 25 different portfolio combinations. As stated previously, the generation of portfolios is a two-step process containing development of optimized capacity expansion plans using System Optimizer and then creation of a detailed financial analysis using MIDAS. Enterprise Planning personnel provided a demonstration of System Optimizer, including a walkthrough of validation methods within the system and sensitivity modeling components. Enterprise Planning personnel also provided an explanation and demonstrated utilization of the MIDAS software.

A part of the process for TVA is developing forecasts for economic data, including gross domestic product, nonfarm employment, customer count, system load, and energy demand. We interviewed select TVA personnel to determine sources of forecasting information and methods for incorporating feedback into the IRP process. Enterprise Planning personnel demonstrated the PI Plus model and the forecasting of national economic data and TVA regional economic data. Enterprise Planning personnel also walked us through additional modeling techniques for developing elasticities used in conjunction with PI Plus and the process for developing and adapting TVA load shapes for scenarios.

[31] Probabilistic modeling considers an element of chance, and deterministic modeling assumes all data is known.

TVA utilizes AURORAxmp electricity market forecasting tool to generate commodities forecasting for the strategic PSP and the IRP. Enterprise Planning personnel discussed the use of this tool for the IRP and demonstrated utilization of the tool. Specifically, we observed input screens reflecting the type of data inputs used in the model and how the transmission system and related constraints react to various commodity prices based on a modeling generation.

## IRP ANALYSIS AND EVALUATION

TVA developed metrics to analyze the portfolios generated in the 2015 IRP. We reviewed the IRP scoring and reporting metrics to determine whether the metrics reflected stakeholder input and were consistent with TVA's strategic mission and imperatives. We also reviewed benchmarking information provided by ScottMadden to determine inconsistencies with other utilities. We noted that TVA evaluated stakeholder concerns and developed sensitivity models in response to stakeholders comments. Based on our analysis, we concluded the steps taken to analyze and evaluate the IRP were adequate.

### Metrics

The IRP project team developed two sets of metrics, including scoring metrics and reporting metrics. The scoring metrics were developed to assess the performance of each strategy in different scenarios. Reporting metrics were included in the IRP as informational measures to help clarify or expand on information. These metrics were categorized by cost, financial risk, environmental stewardship, valley economics, and flexibility. Scoring metrics and associated descriptions are included in Table 3.

| Category | Scoring Metric | Definition |
|---|---|---|
| **Cost** | 20-Year Expected value PVRR | The total plan cost (capital and operating) expressed as the PVRR over the 20-year study period (generated from the stochastic analysis). |
| | Average System Cost ($/MWh), Year 1-10 | Average system cost for the first 10 years of the study, computed as the levelized annual average system cost (revenue requirements in each year divided by sales in that year). |
| **Risk** | Risk/Benefit Ratio | Area under the plan cost distribution curve between P(95)and expected value divided by the area between expected value and P(5). |
| | Risk Exposure | The point on the plan cost distribution below which the likely plan costs will fall 95% of the time based on stochastic analysis. |

| | | |
|---|---|---|
| **Environmental Stewardship** | $CO_2$ Annual Average Tons | The annual average tons of $CO_2$ emitted over the study period. |
| | Water Consumption | The annual average gallons of water consumed over the study period. |
| | Waste | The annual average quantity of coal ash, sludge, and slag projected based on energy production in each portfolio. |
| **Flexibility** | System Regulating Capability | The annual system regulating capacity expressed as a percentage of peak load; this is a measure of the ability of the system to respond to load swings. |
| **Valley Economics** | Percentage Change in Per Capita Income | The change in per capita personal income expressed as a change from a reference portfolio in each scenario |

**Table 3**

We reviewed the 2015 IRP scoring and reporting metrics to determine whether the metrics reflected stakeholder input and were consistent with TVA's strategic mission and imperatives. TVA's mission is to serve the people of the Valley through providing energy, economic development, and environmental stewardship. To meet the mission, TVA focuses on four strategic imperatives, including rates, asset portfolio, stewardship, and debt. TVA's goal is to balance rates and debt so that TVA maintains low power rates while living within its means and recognizing the trade-off between asset portfolio optimization and being responsible stewards of the Valley's environment and natural resources.

TVA was intentional in aligning the IRP to its mission and strategic imperatives. The IRP project team deliberately considered both the environmental stewardship and economic mission within IRP metric categories. TVA also considered the energy mission and asset portfolio imperative in the development of the flexibility metric. Specifically, the flexibility metric measured responsiveness of each generation portfolio by evaluating the type and quantity of resources and the extent to which the mix can easily follow load swings. Rate revenues and debt were indirectly considered as part of metric development through the creation of balance sheet and income statement data and consideration of overall debt limit in each optimization run.

We also reviewed benchmarking information prepared by ScottMadden related to metrics, which determined TVA's metrics generally aligned with those of other utilities. While we did not recalculate the metrics, we observed select meetings where metric definitions and calculations were discussed in detail. Specifically, we observed metric team meetings, IRPWG meetings, RERC meetings, public update sessions, and draft IRP meetings where metrics were vetted. We also noted in best practice documentation that utilities should calculate two different measures of the PVRR. According to the documentation, the first should

measure the variability of resulting PVRR costs under the different scenarios and the second should measure the severity of any bad outcomes. TVA's PVRR calculation applies an 8-percent discount rate and is the present day value of all future costs for the study period, discounted to reflect the time value of money and other factors such as investment risk. TVA indirectly considered the second measure in its risk ratio calculation. The risk ratio is a measure of risk that plan cost will exceed the expected value. This metric is calculated by dividing the difference between higher cost section of the cost distribution and the expected value by the expected value.

**Sensitivities**
Sensitivities were generated for nuclear, EE and demand response, renewables, resources, and key drivers. Through meeting observations, we determined the sensitives were generated in response to stakeholder questions and concerns. We also noted the overall conclusion of the sensitivity results confirmed TVA's original case study results formed a reasonable boundary of future resource additions.

## SEIS

We evaluated whether the draft SEIS addressed all relevant environmental factors. To evaluate the draft SEIS, we (1) interviewed TVA personnel and observed IRP meetings, (2) determined whether lessons learned from 2011 were incorporated into the SEIS process, (3) reviewed available benchmarking information, (4) determined whether the draft SEIS incorporated relevant EIA and APPA information, and (5) compared the 2011 EIS with the draft 2015 SEIS. Based on our review of this information, we determined considerations included in the SEIS were adequate. According to the NEPA Compliance Specialist, lessons learned identified in the 2011 IRP included integration with the IRP development teams earlier than in the 2011 EIS. We confirmed this lesson learned was incorporated into the 2015 IRP process.

The NEPA Compliance Specialist also identified benchmark sources for the SEIS as the Bonneville Power Administration, the Pacific Northwest Planning Council, and Public Service New Mexico. Based on the NEPA Compliance Specialist's descriptions of the source information, we reviewed source documentation and concluded the process for benchmarking the environmental review was adequate. We also compared TVA environmental consideration in the SEIS process to relevant EIA and APPA information and identified no exceptions.[32] As part of our review, we compared the 2011 EIS to the 2015 draft SEIS and did not identify differences that needed to be addressed in the 2015 draft SEIS.

[32] We did not compare EPA information to the SEIS but rather relied on the collective experience and knowledge of SEIS contributors to cover relevant EPA topics.

# CONCLUSION

Developing a plan to address future events is difficult considering forecasts are always erroneous; however, contingency planning is necessary in an ever-changing environment. There are many considerations in planning for unforeseen events spanning 20 years into the future. In our opinion, TVA's process for developing the 2015 IRP adequately considered alternative scenarios and strategies to develop such a tool. Collaborating with external stakeholders not only enhanced the planning process but also served to educate the public about resource planning at TVA. While all parties in the process did not always agree on decisions made, the collaboration exhibited by internal and external stakeholders was a testament to the dedication of these individuals to aid in the creation of a robust IRP.

We applaud the efforts of the IRP project team to foster continuous improvement within the IRP process. Specifically, the team incorporated lessons learned from the 2011 IRP and considered modeling of resources, such as EE and transmission. Additional continuous improvement efforts included the identification of lessons learned from the 2015 IRP to be incorporated into future IRPs.

# OBJECTIVE, SCOPE, AND METHODOLOGY

We evaluated the adequacy of the Tennessee Valley Authority's (TVA) development process for the 2015 Integrated Resource Plan (IRP), including demand-side and supply-side strategies. The scope of our audit included the commencement of the IRP process on October 31, 2013, through the IRP's approval by the TVA Board of Directors on August 21, 2015, and the corresponding Supplemental Environmental Impact Statement (SEIS). We conducted this audit in conjunction with the development of the IRP, periodically providing results of our analysis to TVA management. We obtained an understanding of internal controls related to our audit objective but did not perform testing of internal controls. To achieve our objective, we evaluated the IRP framework; data inputs; scenarios, strategies, and metrics; the environmental factors in the SEIS; and the draft and final IRP and SEIS. To evaluate the adequacy of the process, we assessed whether the:

- IRP was adequately designed to allow for internal and external stakeholder input by:
  - Interviewing the IRP Project Manager to reflect plans for obtaining input from the TVA Board and external stakeholders, including elected officials and the public.
  - Interviewing (1) select internal stakeholders and (2) TVA liaisons with external stakeholders to obtain feedback regarding the IRP process for input.
  - Attending select internal and external stakeholder meetings to observe whether input was allowed into the process.
- IRP framework included an adequate risk analysis covering relevant internal and external risks by:
  - Obtaining the Government Accountability Office's (GAO) October 2011 report on TVA resource planning, "Full Consideration of Energy Efficiency and Better Capital Expenditures Planning Are Needed," and comparing relevant findings and recommendations from the GAO's report on TVA's 2011 IRP to the 2015 IRP process.
  - Interviewing the IRP Project Manager for risks pertaining specifically to the IRP project and risks identified in the GAO report. In addition, we interviewed project team members to obtain information related to the analysis of relevant risks.
  - Interviewing Enterprise Risk Management personnel to determine whether their input was obtained and/or considered in the IRP process.
  - Reviewing second and fourth quarter 2013 organizational risk maps to identify risks related to minimal load growth for comparison to risks identified within the IRP process to determine whether high-level risks have been considered.
  - Reviewing the United States (U.S.) Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2013 risk considerations for

comparison with risks considered in the IRP to determine whether risks were considered.

- IRP framework (1) reflected government and industry common and best practices and (2) incorporated lessons learned by:
  - Identifying common practices related to IRP processes. These included practices identified by American Council for an Energy-Efficient Economy (ACEEE); GAO; American Public Power Association (APPA); Hirst, Goldman, and Hopkins[1] through scholarly research; and Synapse Energy Economics[2] through a survey of state integrated resource planning rules and requirements, dated April 28, 2011.
  - Identifying and reviewing governmental and industry best practices related to IRP framework for comparison to TVA practices. These best practices included information prepared for the U.S. Agency for International Development by the Tellus Institute[3] and data from Synapse Energy Economics.
  - Interviewing TVA personnel to identify (1) resource-planning best practices, (2) lessons learned from the 2011 IRP, and (3) actions taken by TVA to incorporate best practices into the IRP framework.
- IRP scenarios and associated uncertainties and strategies, including related attributes, were reasonable by:
  - Observing IRP team meetings and reviewing documentation for the development of (1) scenarios and associated uncertainties and (2) strategies and associated attributes.
  - Comparing TVA-developed scenarios and strategies to the EIA-developed cases (i.e., scenarios) to determine whether scenarios and strategies were designed to address "plausible futures" and were reasonable. We also compared gross domestic product data, nonfarm employment rates, consumer price index, and gas and coal prices to the 2013 and 2014 EIA AEOs.
  - Reviewing ScottMadden benchmarking results for comparison of TVA-developed scenarios and uncertainties as well as strategies to comparable utilities.
  - Comparing select uncertainties including carbon dioxide ($CO_2$) prices, demand, load, and on-peak power prices to values in the 2015 strategic power supply plan (PSP), which was used as the Current Outlook for modeling.
  - Comparing $CO_2$ prices with the U.S. government's social cost of carbon as this was considered an authoritative source.

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[1] Eric Hirst was an employee of Oak Ridge National Laboratory; Charles Goldman was an employee of Lawrence Berkeley Laboratory; and Mary Ellen Hopkins was with The Fleming Group in Washington, D.C. Articles included "Integrated Resource Planning: Electric and Gas Utilities in the USA," dated 1991; and "Creating the Future Integrated Resource Plan for Electric Utilities," dated 1991.

[2] Synapse Energy Economics is a research and consulting firm specializing in energy, economic, and environmental topics.

[3] Tellus Institute is a nonprofit research and policy organization based in Boston, Massachusetts.

- IRP modeling demand-side and supply-side inputs, including forecasting, were reasonable by:
  - Observing IRP team meetings and reviewing documentation for the development of modeling as well as forecasting inputs and techniques.
  - Reviewing ScottMadden benchmarking results for TVA's modeling approach, analysis, evaluation criteria scorecard, and trends in comparison with other utilities.
  - Comparing TVA modeling inputs with associated information from the EIA, Electric Power Research Institute, Edison Electric Institute, APPA, North American Reliability Corporation, Nuclear Energy Institute, and ACEEE. The comparison included conducting searches of key demand-side and supply-side topics from the sources listed and comparing the results to areas considered or included in the IRP. We did not examine modeling systems or recalculate modeling results.
  - Comparing select inputs from TVA's 2015 strategic PSP to the IRP Current Outlook to determine whether there were any inconsistencies.
  - Reviewing conclusions performed by Navigant Consulting on IRP modeling results, including work related to modeling transmission inputs, to identify any inconsistencies.
  - Obtaining explanations for and observing demonstrations of TVA modeling and forecasting systems and software, including System Optimizer;[4] MIDAS;[5] PI Plus model by Regional Economic Models, Incorporated;[6] and AURORAxmp electricity market forecasting tool.
- Analysis and evaluation of IRP results were reasonable by:
  - Observing IRP team meetings and reviewing documentation for the development of metrics.
  - Comparing scoring metrics with TVA's mission and imperatives to identify inconsistencies.
  - Reviewing sensitivities for comparison with stakeholder concerns to identify inconsistencies.
- Draft SEIS considered relevant environmental factors by:
  - Observing IRP meetings and interviewing select TVA staff to determine whether relevant input was considered and incorporated into the process.
  - Reviewing the 2011 Environmental Impact Statement for lessons learned and items to be carried forward to the future SEIS, comparing this

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[4] System Optimizer is a capacity optimization model that uses a simplified dispatch algorithm to compute production costs and a "representative hours" approach in which average generation and load values in each representative period within a week are scaled up appropriately to span all hours of the week and days of the months.

[5] MIDAS is a strategic planning software tool that uses a chronological production costing algorithm with financial planning data to assess plan cost, system rate impacts, and financial risk.

[6] PI Plus is used to model "the multiplier effects of each strategy's expenditures that stimulate the regional economy and its electric bills." TVA's model has been tailored to the TVA region by county and optimized to capture the interindustry and interregional linkages with surrounding counties and the rest of the U.S.

information with the draft SEIS, and communicating observations to the National Environmental Policy Act's Compliance Specialist.

- Reviewing benchmarking information, where available, related to the SEIS process to determine whether benchmarking information was incorporated or considered in the process.
- Determining whether environmental metrics (1) reflected stakeholder input and (2) were consistent with TVA's strategic objectives and mission.
- Reviewing information from the EIA and APPA, which included reference to Environmental Protection Agency sources, to determine whether relevant information was considered in the IRP SEIS process.

- Draft and final IRP and SEIS documents reasonably incorporated feedback TVA received in response to the draft report, aligned with TVA's mission and strategic objectives, and included reasonable risk responses to achieving those objectives by:
  - Reviewing communications to the TVA Board to determine engagement in the process and incorporation of feedback.
  - Interviewing internal stakeholders to obtain feedback concerning whether input was incorporated into the final reports.
  - Reviewing external stakeholder input to determine if it was considered in final documents.
  - Reviewing the final IRP and SEIS for alignment with TVA's mission and strategic objectives and if it included reasonable risk response.

Our fieldwork was conducted from November 2013 to September 2015. We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objective. We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective.

# Comparison of TVA's 2015 IRP to Other IRP Practices

| Practice | TVA | Common Practices | | | | | | Best Practices | |
|---|---|---|---|---|---|---|---|---|---|
| | | ACEEE | GAO | APPA | Hirst, Goldman, & Hopkins | Hirst & Goldman | Synapse Survey | U.S. AID | Synapse |
| Explicit objectives in qualitative terms | ✓ | | | | | ✓ | ✓ | ✓ | |
| Quantifiable criteria for measuring achievement of each objective | ✓ | | | | | | | ✓ | |
| Inclusion of regulatory requirements | ✓ | ✓ | | | | | | ✓ | ✓ |
| Input from stakeholder groups (customers, environmental organizations, independent power producers, government organizations, chambers of commerce) and technology experts | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5- 30-year planning horizon | ✓ | | | | | ✓ | ✓ | ✓ | ✓ |
| Data on demand & load growth | ✓ | | | | | | ✓ | ✓ | |
| Demand forecast using econometric analysis, end-use simulation, or a combination of the two | ✓ | ✓ | ✓ | | | | | ✓ | ✓ |
| Range of forecasts to reduce uncertainty | ✓ | | ✓ | | | ✓ | | | |
| Capacity planning including reserves & reliability | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ |
| Capacity gap – need for additional resources | ✓ | | ✓ | | | ✓ | | | ✓ |

| Practice | TVA | Common Practices | | | | | | Best Practices | |
|---|---|---|---|---|---|---|---|---|---|
| | | ACEEE | GAO | APPA | Hirst, Goldman, & Hopkins | Hirst & Goldman | Synapse Survey | U.S. AID | Synapse |
| Inclusion of all feasible supply-side, demand-side, & transmission resources available within the planning period, including fuel & technology diversity | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Inclusion of generating unit retirements & decommissioning costs | ✓ | | | | | | ✓ | | ✓ |
| Inclusion of environmental/social factors and costs through characterization/description, ranking/weighting, control costs, damage assessment, or emission targets (but completed as separate document) | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Inclusion of emissions treatment & waste disposal | ✓ | | | | | | | ✓ | |
| Inclusion of economic development considerations | ✓ | | | | ✓ | ✓ | | | |
| Economic screening | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Scenario/strategy analysis of internal & external factors, including availability, unit size, capital cost, lead time, operating & fuel costs, reliability, flexibility, load shapes, & reserves | ✓ | | | | | ✓ | ✓ | ✓ | ✓ |
| Sensitivity analysis by using base case (best estimate) & several high/low alternative forecasts | ✓ | | | | | ✓ | | ✓ | ✓ |

| Practice | TVA | Common Practices | | | | | | Best Practices | |
|---|---|---|---|---|---|---|---|---|---|
| | | ACEEE | GAO | APPA | Hirst, Goldman, & Hopkins | Hirst & Goldman | Synapse Survey | U.S. AID | Synapse |
| Risk assessment, including supply availability, fuel prices, load growth, electricity spot prices, variability of hydroelectric resources, market structure, environmental regulations, emission regulations, lead time, unit size, flexibility, demand-side management, & construction/capital/operating costs | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| Description of preferred plan | ✓ | | | | | ✓ | | ✓ | ✓ |
| Implementation schedule for key activities, including short-term specifics, milestones, & budgets | ✓ | | | | | ✓ | ✓ | ✓ | ✓ |
| Alternative plans in case conditions change (high-level guidance) | ✓ | ✓ | | ✓ | | ✓ | | ✓ | |
| Ongoing monitoring of plan & evaluation of its effectiveness, including need for new IRP | ✓ | | | ✓ | | | ✓ | ✓ | |
| 2-5 year planning cycle with interim updates | ✓ | | | | | | ✓ | ✓ | ✓ |
| Process documentation (including data, models, & other analytics), draft/final reports, and the TVA Board package, along with terminology, defined early in the process | ✓ | | | ✓ | | ✓ | | | ✓ |