Memorandum from the Office of the Inspector General

September 29, 2022

Joseph J. Hoagland
Scott W. Hunnewell

REQUEST FOR FINAL ACTION – EVALUATION 2021-17261 – TVA'S EVALUATION OF NEW TECHNOLOGIES

Attached is the subject final report for your review and final action. Your written comments, which addressed your management decision and actions planned or taken, have been included in the report. Please notify us when final action is complete. In accordance with the Inspector General Act of 1978, as amended, the Office of the Inspector General is required to report to Congress semiannually regarding evaluations that remain unresolved after 6 months from the date of report issuance.

If you have any questions or wish to discuss our findings, please contact Meghan H. Petty, Senior Auditor, Evaluations, at (423) 785-4812 or E. David Willis, Director, Evaluations, at (865) 633-7376. We appreciate the courtesy and cooperation received from your staff during the evaluation.

David P. Wheeler
Assistant Inspector General
(Audits and Evaluations)

MHP:FAJ
Attachment
cc (Attachment):
TVA Board of Directors
Robert M. Deacy, Sr.
Robert J. Duncan
Buddy Eller
David B. Fountain
Lucia W. Harvey
Jim R. Hopson
Jeffrey J. Lyash
Jill M. Matthews
Timothy S. Rausch
John M. Thomas III
Ben R. Wagner
OIG File No. 2021-17261

Office of the Inspector General

Evaluation Report

To the Vice President, Innovation and Research; and the Vice President, New Nuclear Program

TVA'S EVALUATION OF NEW TECHNOLOGIES

Evaluation Auditor
Meghan H. Petty

Evaluation 2021-17261
September 29, 2022

ABBREVIATIONS

DOE	Department of Energy
ER&TI	Enterprise Research and Technology Innovation
FY	Fiscal Year
GAO	U.S. Government Accountability Office
I&R	Innovation and Research
NNP	New Nuclear Program
NTI	Nuclear Technology Innovation
OR&S	Operations Research and Support
R&D	Research and Development
SPP	Standard Programs and Processes
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
TVA	Tennessee Valley Authority
VP	Vice President

TABLE OF CONTENTS

APPENDIX

Evaluation 2021-17261 – TVA's Evaluation of New Technologies

EXECUTIVE SUMMARY

Why the OIG Did This Evaluation

According to the Tennessee Valley Authority's (TVA) Chief Executive Officer, advancements in technology are required for TVA to achieve its net-zero carbon goal by 2050. TVA plans to add a mixture of solar and storage resources in the current decade, while emerging technologies will play a role in the 2030s and beyond. Due to risks associated with adopting unproven or immature technologies, we performed an evaluation to assess TVA's methods for evaluating new technologies. Our review focused on the evaluation of new resource technologies because of their high costs and operational importance.[i]

What the OIG Found

We determined TVA has not established consistent methods for evaluating new technologies. Specifically, we found TVA has not (1) adopted a formal method for evaluating technology readiness or (2) managed technology readiness throughout projects. Over the past decade, TVA has generally adopted commercially available, mature resource technologies. However, as TVA considers integrating new resource technologies (such as small modular reactors), establishing consistent methods for evaluating new technologies may reduce negative consequences such as cost increases, schedule delays, or delivering lower capability than expected.

We also determined TVA has taken limited steps to address previously identified programmatic weaknesses related to Standard Programs and Processes and records management. TVA could be better positioned to integrate emerging technologies in the future if the programmatic issues were addressed.

What the OIG Recommends

We recommend TVA management take actions to (1) improve new technology evaluation consistency and (2) address programmatic weaknesses.

[i] Resource technologies are power generation and energy storage alternatives that can be used as new capacity to meet future load. For the purpose of our evaluation, we considered new resources as those that were new or novel to electric utilities or to TVA.

EXECUTIVE SUMMARY

TVA Management's Comments

In response to our draft report, TVA management provided planned actions to our recommendations and additional information about research and development activities at TVA. See the Appendix for TVA's complete response.

Auditor's Response

We concur with TVA management's planned actions for the recommendations.

BACKGROUND

The Tennessee Valley Authority (TVA) Act charges TVA's Board of Directors with affirming TVA's objectives and missions, "including being a national leader in technological innovation, low-cost power, and environmental stewardship." According to the Department of Energy (DOE), technology development is the (1) process of developing and demonstrating new or unproven technology, (2) application of existing technology to new or different uses, or (3) combination of existing and proven technology to achieve a specific goal.[1] Resource technologies are power generation and energy storage alternatives that can be used as new capacity to meet future load. Examples of resource technologies are biomass energy generation, coal-fired generation, energy storage, natural gas-fired generation, nuclear generation, solar generation, and wind energy generation.

TVA contracts much of its research and development (R&D) work with research partners, including the Electric Power Research Institute, the Centre for Energy Advancement through Technological Innovation, the National Carbon Capture Center, Oak Ridge National Laboratories, and multiple universities. As of July 2021, TVA had three innovation groups tasked with R&D activities:

- **Operations Research and Support (OR&S)** – Consisted of seven staff members who worked with industry partners and subject matter experts within business units at TVA to identify research and technology needs and prioritize research to be executed collaboratively with industry partners.
- **Enterprise Research and Technology Innovation (ER&TI)** – Consisted of eight staff members who facilitated strategy and demonstration projects for adoption of new technologies at scale within TVA's power system. ER&TI was formed in February 2020 to define and advance six transformational innovation initiatives.[2]
- **Nuclear Technology Innovation (NTI)**[3] – Consisted of seven staff members tasked with R&D activities related to new nuclear generation at TVA.

During the course of our evaluation, in February 2022, TVA announced a fourth group tasked specifically with development of the Clinch River Small Modular Reactor Project.[4] In addition to these groups, technology development efforts involve coordination across many TVA business units, including Commercial Energy Solutions, Environmental, Fuels and Hedging, Nuclear, Power Operations, Transmission Planning, and Transmission Operations.

---

1 For the purpose of our evaluation, we considered new resources as those that were new or novel to electric utilities or to TVA.

2 TVA's six transformative innovation initiatives focus on Advanced Nuclear Solutions, Connected Communities, Decarbonization Options, Electric Vehicle Evolution, Regional Grid Transformation, and Storage Integration.

3 During the course of our evaluation, TVA renamed NTI to New Nuclear Program (NNP).

4 Clinch River is a 935-acre site in Roane County, Tennessee, for which TVA holds the nation's only early site permit from the Nuclear Regulatory Commission. TVA's goal is to have a reliable, affordable, flexible, and clean advanced reactor option deployed and operational in the 2032 time frame at Clinch River.

Best Practices for Development of New Technologies in Federal Programs

The U.S. Government Accountability Office (GAO) issued its *Technology Readiness Assessment Guide*[5] in 2020 to establish a methodology for evaluating technology maturity based on best practices for use across the federal government. GAO recommends the use of technology readiness assessments (TRA) to evaluate the maturity of technologies and whether these technologies are adequately developed to be integrated into a system while managing risk. In its guide, GAO provides a five-step process for creating high-quality TRAs,[6] which includes (1) preparing the TRA plan and identifying the TRA team, (2) identifying the critical technical technologies, (3) assessing the critical technologies using technology readiness levels (TRL), (4) preparing the TRA report, and (5) using the TRA report findings. TRLs are maturity scales, consisting of nine levels where each level requires the technology to increase in readiness until actual operation of the technology is in its final form and proven through successful operations. According to GAO, TRLs have proven to be reliable indicators of the relative maturity of the technologies reviewed in government and commercial acquisitions.

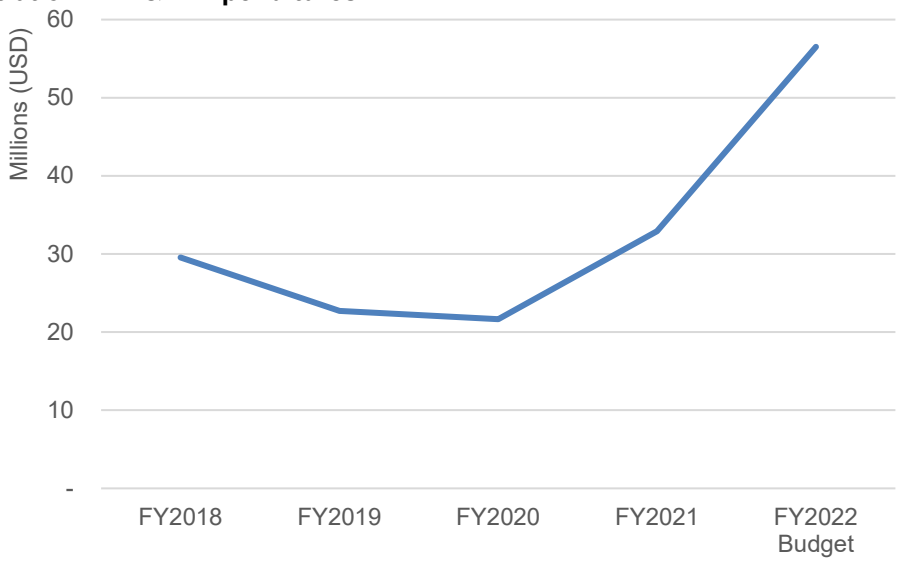
[5] GAO, *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects*, GAO-20-48G (Washington, D.C., January 2020).

[6] According to GAO, a TRA is a systematic, evidence-based process that evaluates the maturity of technologies critical to the performance of a larger system or the fulfillment of the key objectives of an acquisition program, including cost and schedule. TRAs, which evaluate the technical maturity of a technology at a specific point in time for inclusion into a larger system, do not eliminate technology risk. When done well, they can illuminate concerns and serve as the basis for realistic discussions on how to address potential risks as programs move from the early research and technology development to system development and beyond. In addition, TRAs help legislators, government officials, and the public hold government programs accountable for achieving technology performance goals.

Financial Data

Illustration 1 shows TVA's R&D funding from fiscal years (FY) 2018-2021 and anticipated spend in FY 2022.

Illustration 1: R&D Expenditures



Source: TVA

TVA Strategic Intent and Guiding Principles, issued in May 2021, outlined management's intent to invest in existing hydro, gas and nuclear assets and expand solar and battery resources in the near term to further decarbonization goals and energy supply plans. According to TVA's Financial Services group, the increase in R&D spending in FY 2021 and anticipated FY 2022 spending is driven by investments in the transformational innovation initiatives.

Impact of Decarbonization Imperatives on Technology Development

In April 2021, President Biden's administration established a goal of decarbonizing the United States' economy by 2050, with the electricity sector carbon free by 2035. According to TVA's Chief Executive Officer, advancements in technology are required for TVA to achieve its net-zero[7] carbon goal by 2050. This point is reflected in TVA's *Leadership & Innovation on a Path to Net-Zero: TVA and the Energy System of the Future*, released in May 2021:

> The largest contributor to TVA's carbon footprint is emissions from the creation of electricity, mostly by burning fossil fuels . . . In 2020, TVA achieved approximately 63% reduction in its mass carbon emissions compared to 2005 baseline standards. We have a plan to increase that number to 70% by 2030, and see a path to achieve approximately 80% reduction by 2035, through innovation and technologies that we believe will deliver meaningful, impactful

[7] According to TVA, net-zero refers to a state where the amount of carbon emitted is balanced by carbon removed from or offset in the atmosphere.

> progress. We aspire to achieve net-zero carbon emissions by 2050 and to support broader national efforts to decarbonize the economy.

According to *TVA's Guiding Principles and Strategic Intent*, emerging technologies will play a role in the 2030s and beyond. Within the next decade, TVA plans to add a mixture of solar and storage resources. Specifically, to achieve 70-percent reduction of carbon emissions by 2030, TVA's plans include:

- Reducing reliance on coal as additional plants approach end of life and evaluating the impact of retiring the balance of the coal-fired fleet by 2035.
- Investing in the existing carbon-free nuclear and hydro fleets.
- Modernizing the gas fleet to support year-round reliability and integration of intermittent renewable generation.
- Increasing solar capacity to about 10,000 megawatts by 2035.
- Expanding TVA's storage portfolio by adding lithium-ion batteries as costs decline.

Due to risks associated with adopting unproven or immature technologies, we conducted an evaluation of TVA's technology evaluation methods.

OBJECTIVE, SCOPE, AND METHODOLOGY

The objective of our evaluation was to assess TVA's methods for evaluating new technologies. Due to their high costs and operational importance, our review focused on the evaluation of new resource technologies. We limited the scope of the evaluation to new resource technologies with active projects and options for near-term deployments as of September 1, 2021. To achieve our objective, we:

- Reviewed TVA draft innovation procedures and procedures in effect regarding R&D and project management to understand TVA processes, including:
  - TVA Standard Programs and Processes (SPP) 15.0*, Research and Development*
  - TVA-SPP-15.1, *Research and Development Portfolio Planning and Development (Draft)*
  - TVA-SPP-34.000*, Project Management*
  - TVA-SPP-34.001*, Project Management Governance, Oversight, Execution, and Support*
  - *TVA Standard Department Procedure SMRDP-1, Small Modular Reactor Organization, Responsibilities and Training*

- Reviewed the following guides to identify good practices in R&D:
  - *Technology Readiness Assessment Guide* (DOE G 413.3-4A), DOE (2011)
  - *Technology Readiness Assessment Guide* (GAO-20-48G), GAO (January 2020)
- Reviewed prior available reports completed by internal and external auditors to identify related findings, recommendations, and management actions.
- Interviewed innovation personnel in OR&S, ER&TI, and NTI to gain an understanding of their evaluation practices.
- Reviewed the following governance and resource-strategy setting documents and comparative analyses to identify technologies of interest and ongoing and planned projects involving new resource technologies:
  - *2021 Benchmarking Notebook*
  - *Business Plans*, FYs 2021-2025 and FYs 2022-2026
  - *Capacity Plans*, FYs 2021-2023
  - *2021 Competitive Insights Notebook*
  - *Integrated Resource Plan*, 2019
  - *Leadership & Innovation on a Path to Net-Zero: TVA and the Energy System of the Future,* May 2021
  - *Utility Scale Solar Strategy*, June 2021
  - *Strategic Plan*, FYs 2018-2022 and FYs 2022-2026
  - *TVA Strategic Intent and Guiding Principles*, May 2021
- Interviewed resource planning management to understand processes and assumptions made regarding new technologies.
- Identified active projects involving new resource technologies as of September 1, 2021, interviewed relevant personnel,[8] and reviewed project approval packages and other project documentation to determine whether TVA is adequately assessing new technologies during project planning, design, and implementation.
- Reviewed internal technology evaluations for near-term technology alternatives under consideration including analyses of decarbonization options, energy storage alternatives, and small modular reactors.

This evaluation was conducted in accordance with the Council of the Inspectors General on Integrity and Efficiency's *Quality Standards for Inspection and Evaluation*.

[8] Interviewed project managers in Major Projects and Transmission Projects for the identified projects. Interviewed personnel in Treasury and Commercial Energy Solutions regarding the utility-directed solar project origination and execution. Interviewed personnel in Power Operations regarding the aeroderivative gas project origination and execution.

FINDINGS AND RECOMMENDATIONS

We determined TVA has not established consistent methods for evaluating new technologies. Specifically, we found TVA has not (1) adopted a formal method for evaluating technology readiness or (2) managed technology readiness throughout projects. We also determined TVA has taken limited steps to address previously identified programmatic weaknesses related to SPPs and records management.

TVA HAS NOT ESTABLISHED CONSISTENT METHODS FOR EVALUATING NEW TECHNOLOGIES

We determined TVA has not established consistent methods for evaluating new technologies. Based on our interviews with innovation, project, and planning personnel, and file reviews of the three active projects involving new resource technologies,[9] we determined TVA has not (1) adopted a formal method for evaluating technology readiness or (2) managed technology readiness throughout projects.

Evaluation of Technology Readiness

GAO promotes the use of a formal TRA policy as a best practice and encourages adoption; however, GAO notes relatively few federal agencies have guides for assessing a technology's maturity and its readiness for integration. According to GAO, TRAs provide a common language and framework or reference point to facilitate dialogue supported by well-defined measures and methods across organizational disciplines, departments, and business functions. In doing so, the assessments serve as a basis for addressing transition issues, solidifying stakeholder commitments, and identifying potential concerns that may require closer examination to track and monitor them or to develop plans to mitigate potential risks. One of the five steps included in the TRA process is to evaluate technology readiness using TRLs, which is a generally accepted approach in the federal government.

TVA has not formally adopted a TRA framework or a TRL scale. TRLs typically consist of nine levels where each level requires the technology to increase in readiness until actual operation of the technology is in its final form and proven through successful operations. Based on our interviews with OR&S and ER&TI personnel, we determined TVA infrequently evaluates technologies using TRLs; however, TVA does outsource some TRL evaluations to industry research and consulting partners. In the instances where TVA conducts TRL evaluations, we determined there is no standard method used. For example, a report to TVA's Executive Leadership Team showed decarbonization options used a "high," "medium," or "low" readiness scale; a report evaluating small modular reactor technologies used a "readiness and confidence" qualitative description with no

[9] As of September 2021, TVA had three active projects involving new to TVA resource technologies: Lawrence County Solar Project, Vonore Battery Energy Storage System, and Johnsonville Aeroderivative Gas Plant.

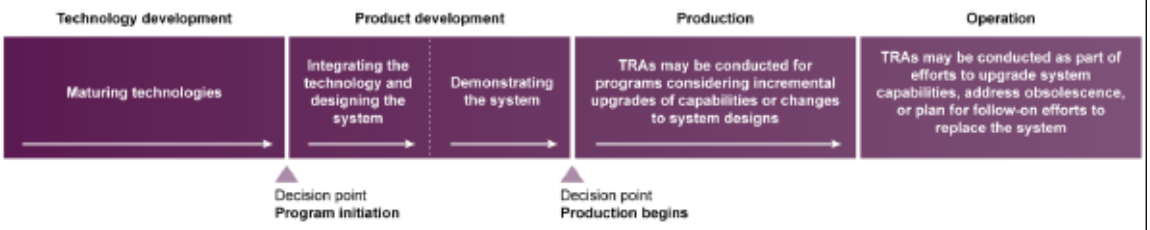
scale; and energy storage alternatives were communicated on a five-category scale (research, development, demonstration, deployment, and mature).

A senior manager expressed their preference for having a high-level understanding of technology maturity (e.g., in research, demonstration, or deployment phase) rather than adhering to a specific TRL scale. However, TRA results, and readiness measures such as TRLs, can facilitate communication at key decision points by providing a common language for discussing technology readiness and related technical risks.

Management of Technology Readiness Throughout Projects

Once a technology has been selected for adoption, GAO indicates passing from one decision point in the project management process to the next should require evidence and documentation to demonstrate criteria for new technologies have been met. Evidence-based documentation may include multiple TRAs that can inform analyses of alternative solutions, gauge the progress of development efforts, and ensure technologies are fully mature before proceeding into production. GAO indicates TRAs are important inputs into project preliminary design and critical design review. TRAs are not typically conducted during production and operation phases of projects, but may be useful in certain circumstances. Illustration 2 shows decision points where TRAs may be needed and the role of TRAs in later project phases.

Illustration 2: Example Project Life-Cycle With Decision Points



Source: GAO-20-48G

According to GAO, when planned and executed well, TRAs are complementary to existing program management activities, system development efforts, and oversight functions by governance bodies. They may also protect managers from unknowingly accepting or being coerced to accept immature technologies into their projects.

TVA's project management processes do not include steps to evaluate technology readiness. Project personnel indicated once the decision is made on the resource technology to build, there are not subsequent assessments performed during projects. In addition, innovation groups had no processes in place to govern technology development during the project phase. Of the three projects we identified that included resource technologies new to TVA's system, two had no involvement from innovation personnel once projects were initiated.
While TVA does not assess technology readiness during project management, TVA does assess technology risk as a part of project complexity ratings.

However, guidance was unclear as to how to rate technologies that are mature but new to TVA's system, and, as a result, ratings did not reflect risks associated with technologies being first-of-a-kind on TVA's system.

TRAs do not eliminate risk, but they do alert decision makers and other stakeholders who are interested to potential areas that could be problematic and inform future actions. To better understand the potential risks, challenges to development, and potential cost and schedule implications, technologies should be reviewed throughout the project, where applicable.

- - - - - -

Over the past decade, TVA has generally adopted commercially available, mature resource technologies.[10] However, as TVA seeks to integrate new resource technologies, such as small modular reactors, having consistent methods for evaluating new technologies may reduce negative consequences such as cost increases, schedule delays, or delivering lower capability than expected.

Recommendations

We recommend the Vice President (VP), Innovation and Research (I&R),[11] and the VP, NNP:

- Adopt a TRA framework to provide common terminology and establish well-defined measures and methods to monitor technology development.
- In coordination with applicable organizations, establish a method for evaluating technology risk and readiness throughout projects involving new technologies.

TVA Management's Comments – TVA management stated TVA's existing process for evaluating new technology includes many readiness factors that are evaluated prior to implementation on the TVA system. Those factors include: the ability to meet technical requirements, support least cost planning, complexity of implementation, fit within the TVA operational system, and technological maturity. TVA management also stated many technological assessments are performed as part of its scouting process.

In addition, TVA management noted as a new technology proceeds from research, development, and demonstration to planning, design, and implementation, the resource needs and risk increase at each stage. For that reason, TVA's development and implementation of new technologies is evaluated with a stage-gate framework that allows off-ramps at each stage based on defined criteria designed at each step. Technological maturity is one of several criteria used to assess success at each stage gate.

[10] A TVA employee indicated a model of combined cycle technology (adopted at Allen Combined Cycle Plant in 2018) was commercially available but probably not mature at the time of adoption. The model was first deployed by the manufacturer in 2017.

[11] ER&TI and OR&S are organized under one VP: I&R.

With regard to our specific recommendations, TVA management agreed that having a standardized TRA process for all technologies developed across the enterprise would help in communicating and understanding the risk of those technologies. TVA management also agreed that documenting the stage-gate framework with better clarity in the processes would benefit the enterprise. Management provided the following planned actions:

- I&R will work with key business units across the agency to select an appropriate technology maturity valuation methodology.
- I&R will work with the Enterprise Project Management Office and key business units across the agency to formalize an enterprise-wide, stage gate framework for development, demonstration, planning, design, construction, and implementation of new technologies.
- The NNP will determine if new business unit specific procedures are needed and revise/develop procedures, if necessary, based on actions taken by I&R.

See the Appendix for TVA management's complete response.

Auditor's Response – We concur with TVA management's planned actions.

TVA HAS TAKEN LIMITED STEPS TO ADDRESS PROGRAMMATIC WEAKNESSES

We found programmatic weaknesses in innovation groups regarding (1) SPPs and (2) records management. These issues were previously brought to TVA management's attention in prior internal and external reviews; however, limited steps were taken to address them.

SPPs

There are no SPPs in effect for OR&S and ER&TI groups.[12] TVA's Operational Assurance group identified the risk and provided recommendations related to the lack of formal processes for R&D in 2017; however, none were put in place. Innovation staff expressed concern that adopting processes and procedures could stifle innovation and may be difficult to formulate because their work is ever-changing. However, SPPs could be used to address ongoing areas of confusion such as (1) when and how the groups will adhere to project management processes, (2) the process for how technologies will be developed and deployed throughout TVA, and (3) expected deliverables from pilots and demonstrations. The groups are currently mapping processes to determine where and how SPPs may be useful; however, as stated above, none are currently in effect.

In addition, the Operational Assurance review identified a need to clarify organizational accountabilities between nuclear and nonnuclear innovation groups. Based on the review, management agreed to finalize organizational accountabilities and document results as a revision to TVA-SPP-15.0, *Research*

[12] TVA-SPP-15.0, *Research and Development*, effective February 2011, is not used by OR&S or ER&TI.

and Development. However, the revision was not completed and we found the roles and accountabilities between the three innovations groups (ER&TI, NTI, and OR&S) in existence as of September 2021 were not formalized and difficult to determine. Based on interviews with staff and management in the three innovation groups, we determined clarity around accountabilities and responsibilities is needed between (1) the three R&D groups and (2) ER&TI and certain TVA organizations (e.g., Commercial Energy Solutions and Economic Development). Since multiple groups are charged with innovation and roles have not been clear, inefficiencies and duplication of efforts may occur.

Records Management
According to a 2019 National Archives and Records Administration report, TVA's records management program was not fully aware of what R&D records were being created or maintained by the agency, and records were being maintained on home drives and shared drives. The National Archives and Records Administration indicated TVA must complete records inventories and file plans. We determined R&D groups still have not (1) defined what records created as a result of its research activities should be considered official R&D records and maintained accordingly or (2) determined how such records would be organized and stored in TVA's content management system. As a result, ER&TI and OR&S personnel indicated some records continue to be stored on TVA individual and shared drives. The lack of control over R&D records may lead to lost business-sensitive or proprietary information.

\- - - - - -

With increased expenditures on transformational innovation initiatives and small modular reactors, innovation groups will be subjected to increased scrutiny. TVA could be better positioned to integrate emerging technologies in the future if the programmatic issues were addressed.

Recommendations
We recommend the VP, I&R, and the VP, NNP:

- Develop SPPs to identify roles, responsibilities, and accountabilities for R&D activities.
- Determine what constitutes an official R&D record and store such records in TVA's content management system.

TVA Management's Comments – TVA management stated I&R has already taken steps to refine their SPPs for technology development and made much progress on the gaps identified. TVA management also stated that although they have a consistent way of performing their work, consistent documentation will help improve their efficiency and understanding across the enterprise. In addition, TVA management agreed there is a need to clearly define those research findings that will become official R&D records. Management provided the following planned actions:

- I&R will clarify roles, responsibilities, and accountabilities for I&R functions around new technology development across the enterprise.
- I&R will complete the development of a new SPP reflective of the expanded role of I&R and ensure integration with other project management and operational processes across the enterprise.
- I&R will also work with the Enterprise Content Management team to define official R&D documentation and develop a clear procedure on where documents are housed and made available.
- The NNP will develop a governance document, aligned with the enterprise governance documents issued by I&R, to (1) identify roles, responsibilities, and accountabilities for new nuclear technology activities and (2) establish requirements for NNP records and storage.

See the Appendix for TVA management's complete response.

Auditor's Response – We concur with TVA management's planned actions.

TENNESSEE VALLEY AUTHORITY

400 West Summit Hill Drive, Knoxville, Tennessee 37902

September 21, 2022

Mr. David Wheeler
Assistant Inspector General
Office of the Inspector General
400 West Summit Hill Drive, WT 2C-K
Knoxville, Tennessee 37902

Dear Mr. Wheeler:

RESPONSE TO REQUEST FOR COMMENTS – DRAFT EVALUATION 2021-17261 – TVA'S EVALUATION OF NEW TECHNOLOGIES

Thank you for your evaluation of TVA new technologies. TVA has reviewed the subject report 2021-17261 and provides its response to the OIG recommendations below.

OIG Recommendation 1:

We recommend the Vice President (VP), Innovation and Research (I&R), and the VP, New Nuclear Program:

- Adopt a TRA framework to provide common terminology and establish well-defined measures and methods to monitor technology development.
- In coordination with applicable organizations, establish a method for evaluating technology risk and readiness throughout projects involving new technologies.

Response:

TVA's existing process for evaluating new technology includes many readiness factors that are evaluated prior to implementation on the TVA system. Those factors include: the ability to meet technical requirements, support least cost planning, complexity of implementation, fit within the TVA operational system, and technological maturity. Technologies that are assessed range in complexity and impact based on the problem being addressed. Their maturity can range from early stage through near commercial deployment depending on the complexity and source of that solution. The job of Innovation and Research (I&R) is to not only evaluate these technologies but then work with experts within the industry to mature these technologies for actual implementation in the TVA system.

I&R focuses more on earlier stage development than many of the examples listed in the report. Except for the battery deployment at Vonore and development of Small Modular Reactor (SMR) technology efforts, all other technologies referenced in the report are at a technology readiness level (TRL) 8 or 9 based on the Government Accountability Office (GAO) Technical Readiness Assessment (TRA) Guide. Their risk is not technological maturity but is primarily in implementation and execution risk which is governed under the 34 Series Project Management

Standard Programs and Processes (SPPs). I&R works to mature earlier stage technologies to reduce the technological risk during development for the operational organizations to implement.

As a new technology proceeds from research, development, and demonstration to planning, design, and implementation the resource needs and risk increases at each stage. For that reason, our development and implementation of new technologies is evaluated with a stage-gate framework that allows off-ramps at each stage based on defined criteria designed at each step. Technological maturity is one of several criteria used to assess success at each stage gate.

This framework is currently being utilized for pumped storage, carbon capture, carbon sequestration, and the Clinch River SMR projects.

As an example, a detailed TRA was performed for various nuclear technologies prior to moving into the current phase of work on the Clinch River SMR. A more detailed TRA is currently being created to evaluate the readiness of the Clinch River project for the detailed design phase.

TVA performs many technological assessments as part of its scouting process and includes over 106 in our scouting database that have been scored on a TRL scale. The majority of the technologies scored in this database are less mature technologies that TVA is monitoring the development of, but not necessarily investing in it until a need is identified. Similarly, TVA sponsors independent analyses of many technologies through the industry think-tanks such as Electric Power Research Institute (EPRI). These technologies can be found at: https://techportal.epri.com.

TVA agrees that having a standardized TRA process for all technologies developed across the enterprise would help in communicating and understanding the risk of those technologies. TVA also agrees that documenting our stage-gate framework with better clarity in the processes would benefit both I&R and the overall enterprise when decisions are being made regarding the implementation of any new technology.

Action 1: The VP, I&R will work with key business units across the agency to select an appropriate technology maturity valuation methodology. That methodology will be implemented across the agency to align with SPP efforts and timeline and be effective by August 22, 2023.

Action 2: The VP, I&R will work with the Enterprise Project Management Office (EPMO) and key business units across the agency to formalize an enterprise-wide stage gate framework for development, demonstration, planning, design, construction, and implementation of new technologies by August 22, 2023. Integration of any required changes to the Project Management process would be facilitated by the EPMO.

Action 3: The VP, New Nuclear Program will determine, based on Action 1 and 2 results, if new business unit specific procedures or revisions are necessary, they will be revised / developed and implemented by August 22, 2023.

OIG Recommendation 2:

We recommend the VP, I&R, and the VP, New Nuclear Program:

- Develop SPPs to identify roles, responsibilities, and accountabilities for research and development (R&D) activities.
- Determine what constitutes an official R&D Record and store such records in TVA's content management system.

Response:

I&R has already taken steps to refine our SPP's for technology development and made much progress on the gaps identified in the audit over the last few months. This process has been evolving as the depth and scope of I&R has increased with the addition of the Transformative Initiative efforts. And while we have a consistent way of performing our work, consistent documentation will help improve our efficiency and understanding across the enterprise.

TVA primarily works R&D efforts with many external experts and industry consortia. These partnerships spread the cost and risk of evaluating early-stage technologies amongst many stakeholders. Because of commercial arrangements, many reports regarding technology and research are housed in cloud databases such as EPRI. They are readily accessible and documented for anyone having a valid account. TVA agrees however, that there is a need to clearly define those research findings that will become official R&D records and have them stored appropriately in the TVA system or in a cloud service. As part of our SPP efforts, we will identify a process for records retention of collaborative and potentially proprietary research that aligns with agency record retention policies.

Action 1: The VP, I&R will refine the Governance, Oversight, Execution, and support (GOES) documents to clarify roles, responsibilities, and accountabilities for I&R functions around new technology development across the enterprise that reflects the enhanced scope of the organization and clarifies terms and definitions. New GOES will be effective by August 22, 2023.

Action 2: The VP, I&R will complete the development of a new SPP reflective of the expanded role of I&R and ensuring integration with other project management and operational processes across the enterprise. Existing SPPs will be updated or cancelled and replaced. SPPs will be effective by August 22, 2023.

Action 3: The VP, I&R will work with the Enterprise Content Management (ECM) team to define official R&D documentation and develop a clear procedure on where documents are housed and made available. The resulting document management strategy will be incorporated into the new SPPs and implemented across the enterprise effective by August 22, 2023.

Action 4: The VP, New Nuclear Program will develop a governance document, aligned with the enterprise governance documents issued by the VP, Innovation and Research, to identify roles, responsibilities, and accountabilities for new nuclear technology activities as part of the new nuclear innovation efforts. Additionally, new governance will establish requirements for new

nuclear program records and storage of records in in concert with the process for storage of R&D documentation. SPPs will be effective by August 22, 2023.

The actions that the Nuclear Business unit is taking in response to this audit are being tracked under CR# 1799729.

Thank you again for the work performed by your staff and your feedback. The recommendations identified provides an improvement opportunity which supports our vision of top industry performance.

Signed:

Joe Hoagland, Ph.D.
Vice President, Innovation and Research

Scott W. Hunnewell
Vice President, New Nuclear Program

CKL:MJD

Robert Duncan, LP 4A-C
David B. Fountain, WT 6A-K
Rebecca Coffey, WT 6A-K
Timothy S. Rausch, LP 4A-C
John M. Thomas III, MR 6D-C

OIG File No. 2021-17261