2022 TECHNICAL REPORT

# Emerging Integrated System Planning Methods

## Utility Perspectives and Applications

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*Utility Perspectives and Applications*

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# Abstract

This report documents the experiences of a set of electric companies in the United States that are performing coordinated planning activities across generation, transmission, distribution, and customer-sided resources. The transition to decarbonized energy systems will substantially transform the electric sector in the next few years, and companies are recognizing that a more integrated planning process may help guide planning more cost-effective and reliable power systems than planning individual parts of the system in isolation.

This report shows that applications of emerging integrated system planning processes are diverse across utilities. Their organizational structure, and market and regulatory environments influence the level of integration across departments and affiliated external organizations. This is particularly the case across planning functions, analytical tools, data environments and stakeholder engagement. For many utilities, integrated system planning is a new and evolving process. Companies are either implementing a process that is not yet mature, or they are engaging in preliminary discussions to delineate the nature of their collaborations.

**Keywords**
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## Product Title: Emerging Integrated System Planning Methods: Utility Perspectives and Applications

**PRIMARY AUDIENCE:** Generation, transmission, and distribution system planners in electric companies, state public utility commission (PUC) and related regulatory staff, federal government officials and staff, and other electric sector stakeholders interested in long-range system resource planning.

### KEY RESEARCH QUESTION

This report reviews how different electric companies in the United States are conducting a more coordinated planning process across generation, transmission, distribution, and customer-sided resources. In addition to describing how utilities are implementing the process and applying new frameworks and methods, the paper presents critical insights and lessons learned that other electric companies may use to inform their own integrated system planning efforts.

### RESEARCH OVERVIEW

This report contains a series of perspectives from utilities that are currently applying or beginning to apply emerging methods for integrated system planning. It considers the perspectives of a wide range of utility types depending on their organizational structures and market environments, and details the efforts that these companies are undertaking to either implement a process that is not yet mature or engage in preliminary discussions to delineate the nature of their collaborations.

### KEY FINDINGS

- The application of an integrated system planning (ISP) framework, based on the specific company's organizational structure and the market and regulatory environment, will differ and it may even be challenging to implement. Still, companies are finding ways to integrate functions across the entire electric supply chain, as well as share critical information that can enhance the overall process.
- Salt River Project is a vertically integrated, municipal-owned utility which has relied on increasing the coordination and communication across transmission planning, distribution planning, generation and resource planning, customer programs and forecasting, as well as aligning assumptions across all planning activities.
- The Tennessee Valley Authority is a generation and transmission, federal-owned utility which has recognized that the scope of its integration process is not as explicit as vertically integrated utilities. The company has been focusing on the generation and transmission (G/T) interface between resource planning and transmission planning and working on new processes to enable the co-optimization of G/T resources. On the transmission and distribution (T/D) interface, the company has been interacting with its local power company partners to find ways to integrate them into the company's regional planning process.
- Duke Energy is a vertically and horizontally integrated, investor-owned utility which operates in both regulated and deregulated markets. The company's integrated planning process has relied on an environment that enables the flow of information across all planning activities. While generation planning is currently continuing to use a top-down load forecast approach, distribution planning is transitioning to a bottom-up circuit forecast approach which has entailed reconciling both approaches

for load forecast. The company is in early stages of moving to jurisdictions within ISO/RTO regions, and the implementation of its integrated process will need to be adjusted accordingly.

- Oglethorpe Power Corporation is a member-owned cooperative, that owns and plans for generation only. For the company, a more coordinated integrated planning across G/T/D is challenging. However, it recognizes the value of a more integrated planning process depending on the type of information that can be shared across distinct companies and the level of collaboration that can be agreed.
- National Grid is a transmission and distribution, investor-owned utility which operates in a deregulated market. The company's integrated planning process has been prioritizing T/D planning needs with a focus on non-wire alternative solutions as well as more accurate end-use forecasting, and transmission planning closely coordinated with the regional system operator.

## WHY THIS MATTERS

For many utilities, integrated system planning (ISP) is a new and evolving process. Still, companies from across the spectrum of structures and market environments are finding ways to integrate functions across G/T/D. This set of utility perspectives provides specific examples about emerging applications of an ISP framework, based on the specific company's organizational structure and the market and regulatory environment, and it offers critical insights for other companies thinking about conducting a more comprehensive planning process.

## HOW TO APPLY RESULTS

The utility perspectives in this paper intend to be a technical guidance to help EPRI members and other stakeholders learn about applications of emerging integrated system planning and understand key elements and features that can be incorporated by electric companies in their planning frameworks. Overall key insights are included to show how companies are implementing and addressing the challenges of a more holistic planning process.

## LEARNING AND ENGAGEMENT OPPORTUNITIES

- EPRI's Integrated Strategic System Planning Initiative (ISSP) Board of Directors Initiative. Contact: Daniel Brooks, dbrooks@epri.com.
- Program 40 on Transmission Planning. Contact: Anish Gaikwad, agaikwad@epri.com.
- Program 173 on Bulk System Integration of Renewables and Distributed Energy Resources. Contact: Aidan Tuohy, atuohy@epri.com.
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- Program 178 on Resource Planning for Electric Power Systems. Contact: Nidhi Santen, nsanten@epri.com.
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# Section 1: Introduction

## Overview

New frameworks and analysis tools are emerging throughout the electric power industry for conducting more integrated planning across generation, transmission, distribution, and customer-sided resources as utilities and other stakeholders search for cost-effective ways to achieve myriad electric sector goals. EPRI's Integrated Strategic System Planning Board Initiative (ISSP) [1] is one example of many across the industry developing new tools and methods to assess future expansion plans across supply, T/D delivery, changes in resource mix, end-use load behavior, new transmission and distribution technologies, and at the same time ensure reliable, resilient and affordable power supply. The NARUC-NASEO[1] Task Force on Comprehensive Electricity Planning is another example of a collaborative initiative to develop new approaches to align resources and distribution systems planning processes [2]. However, the actual application of these new methods depends upon the specific structure of the implementing company, the market and regulatory environment within which it sits, and its overall role and responsibilities. A better understanding of how to apply more coordinated planning across historically siloed processes and adjust to their unique circumstances is needed.

## Scope and Content

At present, there is no comprehensive technical guidance on how to apply various emerging integrated energy systems planning methods to company- and market-specific situations. This paper seeks to contribute to closing that gap, extending research from EPRI's technically focused ISSP initiative to develop and deliver information about suitable next steps on the application and implementation for integrated planning. This paper:

- Details how electric companies apply new integrated methods to support their planning processes and goals.
- Considers the perspectives of a wide range of utility types depending on their structures and market environments.
- Includes a series of perspectives from utilities that are currently applying or beginning to apply methods for integrated system planning.

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[1] National Association of Regulatory Utility Commissioners (NARUC) and the National Association of State Energy Officials (NASEO).

# Section 2: Integrated System Planning

## Definition

The transition to decarbonized energy systems creates challenges and opportunities within the electric power industry, motiving the need for innovative methods and tools for conducting more comprehensive planning. Integrated System Planning (ISP) is a process that adopts a holistic planning framework that integrates planning, modeling, and optimization across generation, transmission, and distribution and consumer-sided resources (Figure 2-1). It contrasts with traditional planning where analysis of each system (generation, transmission, and distribution) is—more or less—conducted separately. The expectation is that an integrated framework will help guide planning a more cost-effective and reliable system than planning individual systems in isolation.

The holistic framework shown below is comprised of many elements. The first element considers the drivers that motivate integrated planning. The second proposes four underlying objectives that also drive the need for integrated planning, although there are many. The framework also defines the core planning organizations involved. The names of these groups will vary and may not reside within the same company. Also included are the capabilities needed to perform integrated planning. Some of these are advanced capabilities not yet widely in practice, but nonetheless critical in meeting integrated planning objectives. The last two elements of the framework include process and integration of the tools used within and across each layer of the power system.

Moving toward a truly integrated planning environment will take time. Tools and processes will improve and begin to work with each other more cohesively. As the integration of capabilities, processes, and tools progresses over time, this also allows planners to evaluate more scenarios and improve optimization of grid solutions.

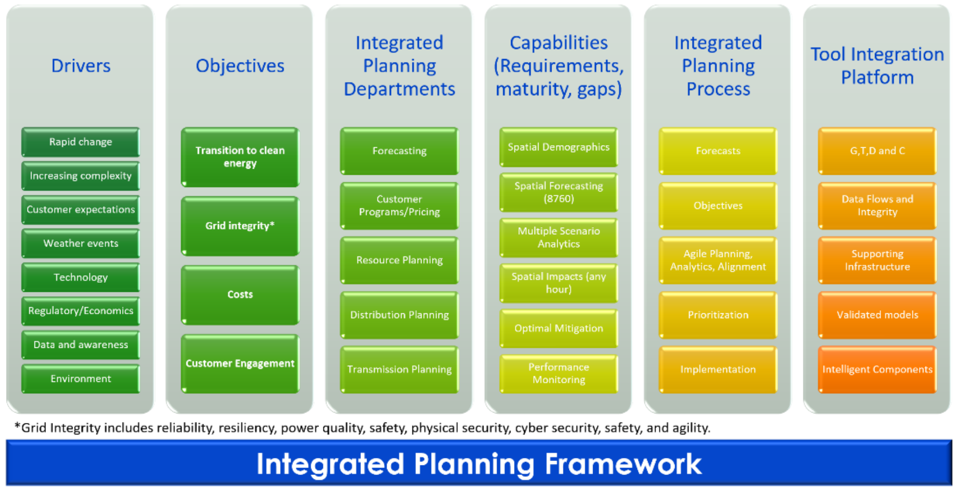


*Figure 2-1*
*Conceptual framework of Integrated System Planning*

The four objectives underlying this framework are interwoven and highly interdependent. As the industry evolves, customers will play more important roles by adopting new technology. These technology solutions must be reliable and affordable for customers to remain engaged, so planners also need to consider how the company will deliver on each.

1. Transitioning to clean energy. In line with climate goals, the electricity sector has been undergoing a significant transition in recent years and has become central in supporting decarbonization of the economy.
2. Maintaining the integrity of the grid. As the complexity of the grid increases, it is critical to maintain reliability, power quality, and safety while improving resilience, security, and agility.
3. Keeping costs low. Increasing demand from electrification and deployment of variable energy resources (VERs) and distributed energy resources (DERs) requires better utilization of infrastructure to keep the affordability of the overall system.
4. Engaging customers. As end-users adopt electricity as their preferred energy source for transportation, heating, cooling, and cooking, planners will need to integrate customers' behaviors and experiences into the planning process.

An ISP process identifies and assesses (technically and economically) viable pathways for a future electricity system that meets a company's goals; develops an integrated portfolio of proposed programs, projects, and timelines; lays out strategic actions needed for implementation of programs and projects in each of the G/T/D/C[2] planning areas; and informs and engages various stakeholders within and outside companies.

[2] Generation, Transmission, Distribution and Customer Programs.

As part of an integrated planning framework, it is crucial to identify key factors impacting resource investments, the robustness of future investment plans, and metrics/procedures for incorporating reliability to ensure viable pathways for future grid investments and innovations. The collaboration of several stakeholders and planners with technical capabilities is also critical to integrate emerging tools and methods that go beyond traditional planning methods. However, these complex integrated tools and analyses tend to be computationally intensive and a careful balance between study time, resource needs, temporal and geographic granularity, and data availability is a key to implementation. As tools and processes become more efficient, that balance may need to be periodically reevaluated.

### ISP Application Framework

A planning entity conducts a resource assessment that may include generation, transmission, distribution, and demand-side resources to plan a future power system. System planning is typically conducted by electric company planners with specialized expertise on resource, transmission or distribution planning. In regions where the transmission grid is managed by regional transmission organizations (RTOs) or independent system operators (ISOs), transmission planning is done by the RTO or ISO as part of a stakeholder process that includes the electric companies [3]. Other state or federal agencies may also be involved in the planning process.

The application of an ISP framework, based on the specific company's organizational structure and the market and regulatory environment, will differ and may be challenging to implement. In some cases, planning aspects will even be addressed by other planning entities. However, while not all planning responsibility may lie within one entity, key elements of an integrated planning process are still relevant to each company since inputs and/or assumptions used in its planning exercises often come from other planning entities. ISP can support companies that normally use relatively static assumptions across specific aspects of the system to develop a more comprehensive perspective; the results of an integrated analysis can be used to update the assumptions and information used in their planning.

Figure 2-2 shows how the application of ISP may vary across companies with different planning responsibilities and modeling and analysis needs. The figure identifies key modeling needs from bulk system generation and transmission expansion to distribution reliability and end-user forecasts. The planning entities have been–based on the cases reviewed in this report–categorized according to their scope of service and whether they are inside or outside an ISO/RTO region.

| Planning/Modeling/Analysis Need | Utility outside ISO/RTO | | | Utility in ISO/RTO | |
|---|---|---|---|---|---|
| | G/T/D | G/T | G-only | G/T/D | T/D |
| Bulk System G&T Expansion | H | H | H | H | M |
| Bulk System Cost, Congestion, Operating Reserve, System Risk | H | H | H | H | M |
| Resource Adequacy, Planning Reserve | H | H | M | H | L |
| Transmission Reliability, Load Flow and Stability | H | H | L | H | H |
| Distribution Reliability, Load Flow, Hosting Capacity | H | L | L | H | H |
| End-user Forecast (Load, DERs) | H | M | M | H | H |

*Figure 2-2*
*ISP Application based on planning entity category and modeling needs. High (H), Medium (M), Low (L) indicate how much the need should be included in the integrated planning effort. Note that Medium or Low indicates that a utility would have to depend on other entities to provide that information to gain full insights as the utility does not typically have the information on its own.*

The utility perspectives presented in the next section suggest that:

- For a G/T/D vertically integrated utility inside an ISO/RTO region, most of the planning responsibilities at bulk level will be considered high priority, and since it operates under ISO/RTO jurisdiction there will be additional trade opportunities. The planning needs at the distribution level and on the consumer-side would be considered high priority to ISP as well.
- For a G/T/D vertically integrated utility outside an ISO/RTO region, most of the modeling needs could be covered by ISP and would be considered high priority. The structure of this utility renders a tighter coordinated planning process, and co-optimization across G/T/D may be possible.
- For a G/T utility that operates outside an ISO/RTO, most of the bulk system and resource adequacy needs would be considered high priority in ISP. Analyses and planning on the distribution network would tend to have low priority. Customer resources and end-user forecasts would be considered important, but the integration would require coordination with customers and distribution utilities that then would feedback to ISP.
- For a G-only utility that operates outside an ISO/RTO, most of the bulk system modeling needs may be included in ISP, much like traditional planning. Customer resources and end-user forecasts could be based on aggregated bottom-up methods, with feedback to ISP. Analyses and planning on the network would tend to have low priority.
- For a T/D utility that operates within an ISO/RTO, transmission planning may be closely coordinated with the system operator, while planning needs at distribution level may be performed by the utility to assess infrastructure and NWA solutions.

# Section 3: Key Insights

For many utilities, integrated system planning (ISP) is a new and evolving process. Companies are either implementing a process that is not yet mature, or they are engaging in preliminary discussions to delineate what collaborations should look like. The market environment and the companies' unique structures add complexity to an ISP process. Moreover, if a company is not fully vertically integrated, then collaboration and coordination across generation, transmission, and distribution may become even more challenging.

Still, as described next, companies from across the spectrum of structures and market environments are finding ways to integrate functions across more of the electric supply chain, as well as share critical information that can enhance the overall process.

### Salt River Project

- Salt River Project (SRP) is a vertically integrated, municipal-owned utility. The implementation of SRP's ISP has relied on increasing the coordination and communication across transmission planning, distribution planning, generation and resource planning, customer programs, and forecasting, which means aligning assumptions across all planning activities.
- The energy transition, including a net-zero carbon power system, prompted SRP to undertake an integrated system planning approach that would find a viable pathway that is reliable and affordable. ISP is a new and ongoing process that began in 2020 with plans to publish results in mid-2023.
- The analysis needs of SRP's ISP have increased in scope and complexity, which required the company to expand its modeling capabilities, create processes around those tools that would enable system-wide scenario analysis, and use a public facing stakeholder process to prioritize large long-term investments under uncertainty.
- The company's integrated planning process has aided the flow of information across planning activities. Resource planning relies on assumptions about system reliability requirements, new and existing resource performance and costs, and a forecast of system load. The results from resource planning are then used by transmission planning, along with assumptions about transmission costs of new resources, grid topology, and inputs from distribution planning about transmission level loads and locations. Distribution planning relies on customer metered data, measured load data, distribution system topology, DER interconnection requests, and

assumptions about load growth and forecasted peak load, which are provided by the company's load forecasting group.

- SRP's ISP has had a comprehensive stakeholder and customer engagement process, which included a diverse set of participants and different touch points under various formats to ensure they collect diverse perspectives and provide information about the overall process.
- SRP has emphasized valuing communication and nurturing the process to support the company being nimble in the future. The company has allocated time for change management during the implementation of the process to ensure that staff across the company sees value and understands the ISP long-term vision.

### The Tennessee Valley Authority

- The Tennessee Valley Authority (TVA) is a federally owned, wholesale electric power generation and transmission utility. TVA has worked on aligning on a plan that everyone across the company agrees upon. This contrasts with TVA's traditional approach, where planning was performed as two separate processes, typically aligned with their respective business units, and with limited interaction between groups and with different objectives in mind.
- TVA has recognized that the scope of its integration process is not as explicit as vertically integrated utilities. As it is inside the company boundaries, TVA has been focusing on the generation and transmission (G/T) interface first and working on new processes to enable the co-optimization of transmission and generation resources.
- TVA's integrated planning relies on an iterative process between G/T, where results from resource planning are used by transmission planning and vice versa to develop and update the company's future investment projects.
- The transmission and distribution (T/D) interface has proven more challenging to implement because it involves more than 150 local power company (LPC) partners and TVA does not perform distribution planning. TVA's interaction has been focusing first on the large LPCs and working with them on pilot projects to understand their planning and reliability needs for more advanced distribution planning.
- TVA's stakeholder engagement has been an extension of the company's integrated resource planning (IRP) process, with several touchpoints to ensure participants can provide input to the process.

### Duke Energy

- Duke Energy is an investor-owned, vertically and horizontally integrated utility. The company's Integrated System and Operations Planning (ISOP) process started in the Carolinas, where the company is under a traditionally regulated market. Early efforts date back to 2017 and 2018, before ISOP was formally launched as an organization in 2019.

- ISOP involves the integration across generation, transmission, distribution and customer segments. The process has focused on enhancing modeling and analytics (e.g., bottom-up approaches to support regional forecasts); creating new processes and data systems; addressing operability of feasible plans; and assessing technologies and non-traditional solutions to support the grid.
- Duke Energy's integrated planning process enables the flow of information across all planning activities. Generation planning continues to use a top-down approach for load forecasting. However, distribution planning is transitioning to a bottom-up circuit forecasting approach to estimate potential overloads. There is a process to reconcile the top-down and bottom-up load forecasts, and a process to better align the information that goes into circuit level forecasting with transmission level analyses.
- Duke Energy has chosen to keep its integrated resource planning, transmission planning, distribution planning, and customer program planning as distinct entities and with a regional presence based on the jurisdictions the company serves, with distinct plans for each region. Notably, the company has organized an ISOP team, with expertise across domains, to support this process.
- The company is in early stages of moving to other jurisdictions in the Midwest, the implementation of ISOP will need to be adjusted to comply with the requirements of the grid operators and the impact of FERC Order No. 2222 on those regions.
- Duke Energy has been interfacing extensively with a large group of external stakeholders, at a level not done previously, which represent a broad range of interests, and differ by jurisdiction.
- Duke Energy recommends change management experts in supporting major company evolutions such as transitioning to an integrated system planning process to ensure fluid communication and relevant staff training.

### Oglethorpe Power Corporation

- Oglethorpe Power Corporation (OPC) is a member-owned cooperative, that owns and plans for generation only. OPC does not engage in formal integrated system planning, as more coordinated planning across generation, transmission, and distribution is challenging for the company given its structure.
- OPC is embarking on a new coordination process between itself, the Georgia Transmission Corporation (GTC), and the Georgia System Operations Corporation (GSOC). The company thinks of this process a valuable venue to discuss potential long-term implications of carbon policy and other regulations, develop joint scenarios for future planning, and share information to enhance modeling processes.
- OPC expects that the three companies' planning departments will be the key players of its evolving collaborative process — GSOC's operations and short-term modeling areas, GTC's system transmission planning within its engineering unit, and OPCs' planning area.

- OPC has identified several challenges for further integration, such as agreement on the overall planning goals across different entities with different planning needs; availability and sharing of information by its distribution co-ops; and availability of resources and time to undertake a more collaborative planning process.

### National Grid

- National Grid is an investor-owned utility that owns and operates transmission and distribution assets in deregulated markets. The company's integrated planning process has prioritized transmission and distribution planning needs, with a focus on non-wire alternative solutions, as well as more accurate end-use forecasting.
- The company considers integrated planning to serve three main functions: (1) to bridge the gap and create a bi-directional flow of information between planning and the rest of the company; (2) to develop processes and an approach to evaluate new technologies and methods; and (3) to guide and coach individuals throughout the company.
- National Grid has adopted an incremental approach that evolves and responds as the company proceeds with its planning exercises, and it is iterative in nature. The company takes one step at a time and attempts a solution that will provide the company benefits in the near term without overthinking how this will affect the long term.
- The company frequently engages with external stakeholders, as it seeks to inform and educate participants about the key technical aspects of National Grid's planning process.
- To manage loads due to potential electrification of heat and transportation, National Grid has been thinking about active distribution network planning and operation. The acquisition of U.K.'s largest electricity network operator is expected to help National Grid better understand the role, function, and integrated planning opportunities of a distribution network operator.

Overall, integrated system planning has been a new experience for most of the companies interviewed, and as such they are still learning the value of the approach, where it can support planning processes, and understanding areas for improvement. For companies with structures where planning functions are more organizationally separate, integration of the various functions that can support integrated system planning may be more challenging. To overcome these barriers, additional effort may be necessary to achieve comparable levels of integration than what has been developed for vertically integrated companies.

# Section 4: Electric Power Industry Applications

This section reviews the ongoing or emerging integrated system planning approaches taken by five different electric utilities across the United States. The companies were selected based on their organizational structure, and market and regulatory environment.

- Salt River Project (SRP): Vertically integrated; municipal-owned utility
- The Tennessee Valley Authority (TVA): Generation and transmission; federally owned utility
- Duke Energy: Vertically and horizontally integrated; investor-owned utility (regulated and deregulated markets)
- Oglethorpe Power Corporation (OPC): Generation only; member-owned cooperative
- National Grid: Transmission and distribution; investor-owned utility (deregulated markets)

## Utility Perspective 1: Salt River Project

### *Company Description*

Salt River Project (SRP) is a community-based, not-for-profit organization that provides water and power to more than two million customers in central Arizona. SRP is composed of two separate organizations: the “Association,” a private water corporation, and the “District,” an electricity provider. The Salt River Project Agricultural Improvement and Power District is one of the main public utility companies in the state and serves most of the Phoenix metropolitan area. A sizable portion of the SRP electric service territory is adjacent to Arizona Public Service. As a vertically integrated utility, SRP provides generation, transmission, and distribution services, metering, and billing services to over one million electric customers. As of 2022, the SRP energy mix is projected to be close to 33,000 GWh, with 26% from coal, 44% from natural gas, 18% from nuclear, 2% from hydro, and about 9% from renewable resources (solar, geothermal, biomass, and wind). The company also buys and sells excess energy on energy markets as needed [4]. SRP is not under the jurisdiction of the Arizona Corporation Commission (ACC) for rates, rules, and regulations.[3]

### *SRP's Definition of Integrated Planning and Motivation*

Integrated System Planning (ISP) has been a priority and a corporate objective of SRP for the past two years. The ISP directs the company on how to prioritize internal resources. The ISP process requires opening the silos of transmission planning, distribution planning, generation (existing fleet) or resource planning (forward-looking), customer programs, and forecasting, which means aligning assumptions across all planning activities and becoming more communicative across the entire enterprise. In addition, SRP's financial planning, and corporate pricing groups[4] have been integrated into the process, as have other areas such as legal, and content and marketing groups who help SRP connect with customers. To make sure that the resulting plans of the ISP process are operable in the future, and consistent with the SRP standards of conduct, the generation and transmission operations team as well as the supply, trading and fuels team review, consult, and coordinate on planning studies and lead operational readiness efforts. The vertically integrated nature of SRP has supported implementing an ISP approach, as many groups can be coordinated within the company, facilitating SRP's motto "planning together, planning better."[5]

SRP's objective with ISP is to find viable power system pathways from 2025 through 2035 that will navigate and work well in any future, including alternate policy drivers, commodity prices, customer's behavior, and more. The company then analyzes the costs, risks, and trade-offs associated with those different pathways to find robust solutions in the long-term. The company is looking for a decarbonization plan that provides the best customer value by being both reliable and affordable. This means anticipating a stepwise approach to ensure that plans that are in place can maintain these critical objectives over time. For example, with a net-zero goal, it is difficult to foresee the make-up of the entire power system or have a precise quantification of customer costs—there is simply too much uncertainty, especially in SRP's service territory that is experiencing such a high rate of growth. This level of uncertainty calls first for quantifying risks and opportunities of SRP's existing 2035 Corporate Goals, understanding how the ISP is feasible, operable, and comprehensive of the cost to achieve. After this stable foundation is achieved, the next goal setting process begins, understanding there will be expectations for increasing ambition toward net-zero goals, but using the ISP as a path to determine *how* to achieve it.

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[3] The ACC has statutorily defined jurisdiction if the SRP issues bonds for financing, applies to build a power plant generating more than 100 MW or proposes to construct power lines of 115 KV or greater [20].

[4] Customer programs include energy efficiency (EE), demand response (DR), and electrification. The pricing group is in charge of time-of-use (TOU).

[5] As of June 2022, SRP's public facing progress of its integrated system plan can be found here [21], in particular in the "Summary Study Plan for SRP's Integrated System Plan" [22].

The energy transition, including decarbonization and changing customer preferences, is a main driver for engaging in this process, given that it is likely to generate a much more complex power system in which renewables will dominate future portfolios and therefore the operation of future systems will be vastly different from today's practices. This expected complexity is fueling the need for new analytical tools in generation, transmission, and distribution; companies are required to expand what is being analyzed at all levels, as well as consider more granular detail to control and manage customer loads as if they were resources. As the company transitions its power system to a less carbon intense system, SRP expects the ISP framework will help achieve a reliable and affordable power system. By providing stable, reliable, safe, and cost-effective power, SRP also expects that ISP will support a larger economy-wide transition to net-zero carbon through electrification.

### *Framework*

As background, SRP has three different types of studies that fall within its planning umbrella:

- The first are special studies, which focus on specific gaps. These may include evaluations of solar hosting capacity, locational needs for new delivery infrastructure and programs, or methodology development for flexible reserve strategies. Special studies are typically conducted as ad-hoc studies, and they can last from one month to a year or more.
- The second type of study focuses on the annual planning process, which is a continuous process to determine investments, and establish near-term budgets.
- The last type of study develops the company's new formal Integrated System Plan (ISP). This study uses a system-wide scenario analysis and public facing stakeholder process to prioritize large long-term investments under uncertainty.

SRP recognized that to "plan together and plan better," it needed to have: (1) an objective setting process and a well-defined question; (2) stakeholders who would offer insights toward that question, considering their various perspectives; (3) a holistic study plan with a system-wide perspective that would result in a robust analysis; and (4) a final document that would record the results of the integrated planning process[6] as shown in Figure 4-1 [5].

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[6] SRP's original integrated planning framework was condensed to four steps, with dozens of steps embedded within those four, that would be ubiquitous to apply across the company.


*Figure 4-1*
*SRP's Integrated planning process*

In addition, SRP formulated two oversight bodies: (1) a planning leadership team that involves a large part of the leaders across the planning and operations organizations and sponsors the study work and the analysis; and (2) a planning coordinating council that involves senior leadership and helps to prioritize work and bring results to the executive level for decision making.

### *Implementation*

SRP used several sources to learn about and begin implementing integrated planning. This included information from the NARUC-NASEO task force on Comprehensive Electricity Planning [2], EPRI's white paper on Integrated Energy Network Planning [3], and NREL's LA100 Renewable Energy Study [6]. Although the utilities have different structures, the company also reviewed the efforts of Duke Energy's Integrated System & Operations Planning (ISOP) initiative [7], and the planning approaches of SMUD (Sacramento Municipal Utility District), Dominion Energy, and Hawaiian Electric. The company worked with outside consulting firms to help build their initial ISP framework and continues to work through efficiencies to implement the current process. Overall, SRP investigated a wide array of solutions and involved different subject matter expertise, electricity user perspectives, and a wide range of consulting perspectives to create a framework that would work for the company's own culture and governance and create value for SRP's customers.

To implement the Integrated Planning Process for the pilot ISP, the company sought additional expertise from consulting partners to shape internal alignment: mapping existing business processes, building analytical framework, developing project objectives, forming a project team, and identifying community stakeholders. In November 2021, the company worked with stakeholders to develop a first of its kind study plan. As of April 2022, the company began performing analyses, with an intended completion date in early 2023. SRP plans to publish results of the ISP in mid-2023.[7] Although the company has not established the frequency of the ISP process yet, the goal is to keep it agile (if it publishes the plan in mid-2023, SRP may at the same time develop the objectives for the next ISP and launch the process soon afterwards). As SRP gains familiarity with the ISP process, it plans to continue adjusting improve communication across departments and continuously improve efficiency across the various steps.

### Stakeholder Engagement

SRP's stakeholder and customer engagement for the ISP process includes a 22-member advisory group—selected to collect diverse customer and community perspectives—that includes environmental NGOs, customers of all different classes, low-income advocacy groups, and tribal interests, among others. The advisory group meets regularly to help SRP prioritize efforts. Additionally, there is a broader stakeholder group with over 110 organizations and growing, inclusive of generation and transmission developers, trade associations, research institutions, and multiple organizations that represent the interests comprised of the 22-member advisory group and others. The company holds information sessions with this larger stakeholder group to provide information about the overall process. Finally, SRP also implemented a research effort to better understand residential customers' expectations and needs. That effort included focus groups, survey work, and preference surveys on cross-sections of customers that represented the company's customer base.

### Modeling Tools and Metrics

For the ISP process, SRP uses several publicly sourced inputs to define the models being used. The list of system-wide modeling tools used is extensive [8]; however, as the company evaluates ways to enhance modeling flexibility other tools are also being considered.

- Tools are being used for several types of analysis, such as load forecasting and customer programs; resource planning and long-term capacity expansion and detailed dispatch simulations; load allocation and load flow analysis considering distributed energy resources (DER) and electric vehicles (EV); large-scale power-flow and dynamic system analysis.
- The company's commercial tools include Itron's SAE, Energy Exemplar's Aurora, Integral Analytics' LoadSEER, and GE's PSLF. [9]

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[7] For the company, it was important that during the objective and study plan phases the scope of the ISP balanced the pilot nature of the effort with the need to capture comprehensive analysis, so the ISP itself and the amount of subsequent analysis needed to tackle in the next months remained manageable.

[8] Information about SRP's ISP modeling ecosystem can be found in [23] and [24].

[9] In general, it is important to note that utilities constantly change tools and often have more than one being used, and all tools need improvements and will be updated accordingly.

SRP conducted workshops to define several metric categories for evaluation of the merits of its integrated system plan, including affordability, reliability, sustainability, and customer preference. Under these categories, there are several metrics aimed at sparking dialog and discussion regarding the various trends and tradeoffs anticipated in the results of the ISP Study Plan[10] analysis such as: $NO_x$, $SO_x$ and $CO_2$ emissions; water outputs; net present value; average rate impact; and many others (see Figure 4-2 [8]).

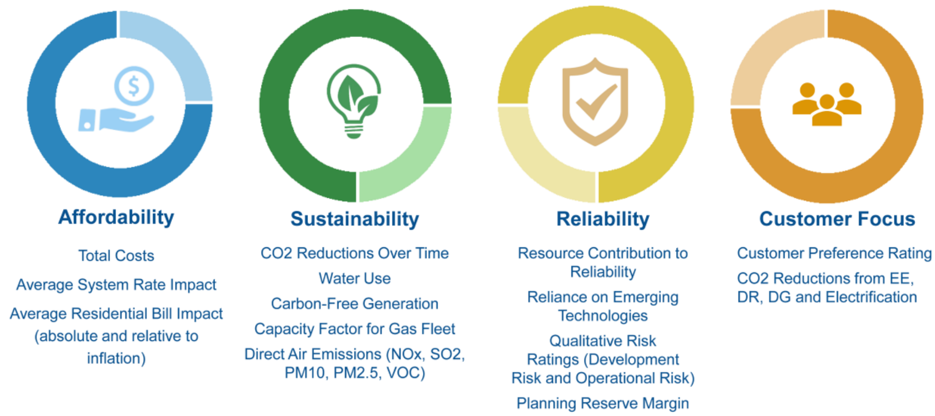


*Figure 4-2*
*SRP's integrated planning process metrics*

### Challenges

As with any first of its kind effort or enterprise-wide change process, SRP recognizes there will be challenges to overcome through the ISP process. One of the biggest challenges is understanding, valuing, and allowing for dialog with the variety of perspectives from the various silos within the company while complying with applicable requirements and limitations. Each staff member may have a different definition or interpretation of the same word, which stems from their business unit's perspective. For example, reliability and operability may be considered differently for the resource planning team and for the operations team.

In terms of the operability of the system, there are significant concerns that the modeling tools and software solutions do not have the level of granularity needed to address the increasing complexity of power systems with emerging technologies (sub-hourly variations or more flexible reserve strategies for instance). An additional challenge of the modeling comes from the uncertainty in performance, supply chain expansion and cost input assumptions for emerging and rapidly developing technologies including solar, wind, batteries, and electric vehicles. As new gaps are identified, new tools are being developed, tested, and

[10] More information about these and other metric categories can be found in the "Summary Study Plan for SRP's Integrated System Plan" [8].

integrated into the company's existing planning processes. This is a complicated process that SRP expects will take some time to implement efficiently.

Another challenge has been change management and communication during the process. ISP is a collaborative process that takes time to socialize within a company, and this may conflict with the near-term needs of the company. If staff does not see the value nor understand the long-term vision, or if the company has not allocated appropriate time for change management, resistance to the process may ensue. Therefore, SRP has emphasized valuing communication and nurturing the process to support the company being nimble in the future.

Finally, SRP's ISP study itself is expected to result in an expansive amount of system plans that require evaluation. The dozens of plans for analysis reflect the company's desire to ensure that ISP outcomes are flexible to accommodate the changes in the market and withstand future policy evolutions. Moreover, these many plans undoubtedly require additional effort from individual units within the company because within each plan are recommended actions to achieve a particular outcome. For example, a plan may call for accelerating a grid enablement pilot or perform additional research on software development, if there is a gap.

While SRP acknowledges they are in the thick of enterprise-wide change, these fundamental steps are recognized as short term challenges with an eye to the long-term gain of proactive planning needed to navigate the energy transition.

## Utility Perspective 2: Tennessee Valley Authority

### *Company Description*

The Tennessee Valley Authority (TVA) is the largest, federally owned energy provider in the United States. Its power service territory covers 80,000 square miles, including most of Tennessee and parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia. The company operates primarily in the generation and transmission space, and supplies power to 153 local power companies (municipal utilities and regional cooperatives), and 56 direct, large energy-intensive industrial customers and federal facilities. TVA provides electricity to approximately 10 million people through a generation portfolio that, as of 2020, includes 42% nuclear, 15% coal, 28% natural gas, 12% hydro, 3% wind and solar, and 1% energy efficiency programs, with a total capacity of almost 37,000 MW [9]. TVA is governed by a Board of Directors nominated by the president of the United States and confirmed by the U.S. Senate. TVA is not regulated by a Public Utility Commission, rather the Board is responsible for establishing broad strategies, goals, and objectives; set long-range plans and policies; and ensure their implementation by the company's staff [10].

### *TVA's Definition of Integrated Planning and Motivation*

TVA's defines integrated system planning as "working across generation, transmission, and distribution systems to invest in elements that optimize and lower costs across the entire equation." Historically, TVA has had a resource planning unit and a transmission planning unit, with teams working together as necessary. However, over the last one to two years, company units have become more tightly integrated because of the larger changes it sees over the horizon. The company recognizes that there is value in transmission planning and generation planning units partnering more closely to co-optimize generation and transmission investments to decrease overall costs. In the long-term, the company also intends to work with its local power companies to better understand their needs, such as grid modernization at the distribution level. While the scope of integration may not be as explicit as vertically integrated utilities, TVA believes it is important to work together with local power companies to help with resources on the distribution system that have the potential to benefit the entire system.

One the main goals of TVA's integrated plan is to create a roadmap and align on a plan that everyone across the company agrees upon. This contrasts with TVA's traditional approaches, where teams worked in relative silos and had different objectives in mind. TVA expects the roadmap to be flexible, and able to adapt with the pace of change. In fact, TVA has created an iterative process that allows changing the plan as inputs and objectives change over time, and keeping groups informed of needs from one another. For example, if resource planning calls for assets addition or retirement, it is important that transmission planning be available to support that request.

There are several drivers for TVA's engagement in integrated planning: (1) achieve the company's long-term asset strategy goals; (2) lower the overall cost of meeting those goals; (3) meet the goals' timeline; (4) reduce the company's carbon footprint; and (5) maintain reliability of the system. There are two additional drivers: (6) resiliency in the face of the expected deployment of DERs and (7) an aspiration for net-zero decarbonization by 2050, which impacts the company's decision-making process and the planning cycle.

Overall, TVA sees integrated system planning as essential to meet the company's long-term objectives, specifically retiring its remaining coal fossil plants by 2035 and interconnecting 10 GW of solar in the same timeframe. These are significant changes to TVA's system that the company will need to enable through careful co-optimization of transmission and generation resources. For example, determining the optimal location for spinning generation across the system, and the gas infrastructure needed to support those units is one challenge the company is currently addressing using an integrated approach. According to TVA, the traditional approach of first studying the interconnection queue and then determining the system upgrades that are needed starts to break down when the system needs such substantial changes over the next 10 to 15 years. The company plans to use the process to get ahead of the decisions made around future projects, especially with long lead times to build, and ensure that, for example, transmission infrastructure is there when it is needed.

### *Framework*

Currently in a nascent stage [11], TVA's vision of an integrated planning process is shown in Figure 4-3. Although the company does not have a documented ISP procedure yet, TVA is currently producing one after a thorough review process and plans to formalize it as an annual exercise in the coming years.

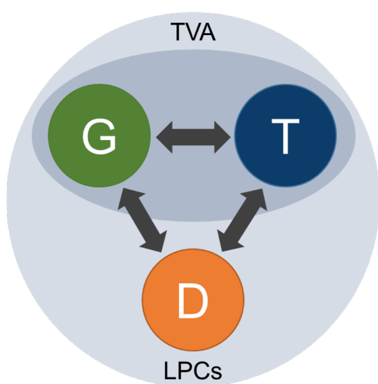


*Figure 4-3*
*TVA's long-term vision of integrated planning*

The main difference between the company's previous long-term planning process and its formal integrated planning process is that the latter requires inputs from a wide variety of internal business units, all of which are combined to perform a resource and capacity assessment. This integrated process has two main interface points:

- The generation and transmission (G/T) interface between resource planning and transmission planning.
- The transmission and distribution (T/D) interface between TVA and the company's local power company (LPC) partners.

The G/T interface follows an annual schedule. It usually starts in the spring with a capital investment plan that follows a mid-year update after considering changes in the macro economy as well as internal conditions. From this point, it takes approximately 4 months for the company to develop its initial resource plan, inclusive of gathering data, running models, analyzing outputs, and revising inputs and re-running scenarios. During this time, the transmission planning team is involved in a portion of the process, as well. The outputs of the resource planning models are provided to the transmission planning team, which then initiates a 4-to-5-month transmission planning process to coordinate with stakeholders, gather inputs, evaluate results from the resource plan, build transmission models, run the transmission studies, and then coordinate on results. Ultimately, this annual process results in a roadmap that identifies the projects the company will propose to undertake. Finally, the planning teams coordinate with finance to ensure that investments in capital projects are aligned with the company's long-term strategy.

Currently TVA is prioritizing the G/T interface as it is inside the company boundaries. The T/D interface is more challenging for TVA because it involves more than 150 LPCs that work independent from the company.

### *Implementation*

To learn more about integrated planning, TVA reviewed Duke Energy's ISOP process and adopted various elements from it, reformulated it to consider TVA's unique characteristics –federally owned utility that operates primarily in generation and transmission, and is regulated by a board of directors rather than a Public Utility Commission. The company has also reviewed the research of national laboratories and academia on integrated planning (e.g., strategies, modeling frameworks), as it has evaluated appropriate approaches for TVA. Additionally, TVA reviewed cases of integrated planning from utilities that participated in market-based systems (such as New York and California); in these cases, an overview of what the companies were implementing was helpful, but TVA acknowledged that it would be difficult to take those approaches and apply them to its circumstances mostly because the operation in these deregulated markets is different from its own. All in all, TVA sees value in identifying lessons learned by these entities.

Although the company previously had a defined process for supply side resource planning, such as creating an annually updated 20-year capacity expansion plan which utilized standard inputs from transmission planning, 2021 was TVA's first full-scale pilot of its new integrated planning process that formally spans both generation capacity expansion and transmission expansion. Also, as part of NERC's compliance, TVA performs a traditional annual transmission assessment 10 years out in the future. However, the company realized that this assessment was missing many of the changes that are expected to occur on the system (e.g., interconnection requests in the company's queue for solar). Therefore, TVA created a new type of assessment called the Resource and Capacity Assessment (RCA) which looks out 15 years and attempts to include long-term goals and build a roadmap for the company. Both are ongoing processes, and the company is looking to make improvements as it draws on lessons from them.

On the T/D interface, presently TVA has been interacting with its LPC partners, particularly the large ones, to find ways to integrated them into the company's regional planning especially as DERs become more important to the Tennessee Valley area. For example, TVA has pilot projects with large LPCs that aim to better understand planning needs for more advanced distribution planning framework, including learning new distribution planning techniques, improving tools, acquiring better data about their own systems, and enhancing skill sets. This in an evolving process as it demonstrated by the TVA's newest initiative on Regional Grid Transformation.[11]

### *Stakeholder Engagement*

The company considers integrated planning as a process that supports the involvement of all participants and TVA's regional stakeholders in a way that allows the company to think about planning in a more holistic way instead of a compartmentalized one. TVA's integrated planning process involves many stakeholders:

- Internally, there is collaboration within the resource and transmission planning groups, and across other units of the company. For example, operations ensures that generation and transmission plans are operable; economic development ensures that plans are incorporating the system's capacity needs; the field team ensures that they can timely support construction of the proposed units.
- Externally, the integrated planning process has separate "touch-points" with stakeholders to ensure they can provide input. Every 4 to 5 years, the company engages from the outset with customers, academia, government officials, environmental groups, and others, as part of the integrated resource planning (IRP) process – which is the overall strategic plan that guides the company from a resource standpoint (e.g., retirements, resource additions). In addition, TVA's Regional Energy Resource Council (RERC) solicits advice from the regional government, customers, academia, and advocacy groups interested in the development and management of energy resources in the Tennessee Valley [12].

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[11] The Regional Grid Transformation Roadmap is being developed by TVA along with a group of LPCs, which will support Valley utilities on building integrated planning capabilities, enhancing grid operations, setting up regional guidelines will allow cross-collaboration, among other goals that are expected to identify opportunities to optimize regional resources [25].

### *Modeling Tools*

The company currently uses several tools to perform integrated planning, particularly around capacity expansion, transmission load flow analysis, resource adequacy planning reserve margins, and production cost modeling.

- A separate data interface tool handles the outputs of the capacity expansion planning model and passes them to the transmission team.
- Commercial tools include, but are not limited to, Anchor Power Solutions' EnCompass software, Siemens' PSS®E, Astrapé Consulting's SERVM model, and Energy Exemplar's Aurora model. [12]

### *Challenges*

TVA has faced many challenges through its ISP process implementation. Two of the biggest challenges have been having enough resources (e.g., staff) and determining effective mechanisms to support the new processes that ISP creates. TVA already has a relatively detailed annual resource planning process, and pursuing integrated planning is only increasing this process' complexity. There are new tasks that staff is now being asked to perform, in addition to their current roles. Also, the plans that result from the ISP process require approvals from a budgeting and financing perspective, and this can be difficult due to high levels of uncertainty over the long time periods the planning is performed for.

As noted above, the company is prioritizing the G/T interface, but also recognizes the importance of working on the T/D interface. TVA does not do distribution planning, so is actively thinking about how to integrate its LPC partners into the regional planning exercise and understand their capacity needs and reliability challenges. This process will involve close coordination with several customers that may not have the same vision[13] and/or expertise in-house for what TVA is trying to accomplish. Integrating the LPCs' planning processes and timelines into the company's own transmission planning process may occur via new feedback loops.

The fact that the plan is looking out 15-20 years makes it very hard to predict the nature of the system over this time (e.g., where solar will be located, when fossil assets will retire, where the system will have a load growth). These uncertainties present a challenge in both ISP and traditional planning. However, the increasing pace of change in the utility industry is making it critical that TVA's resource and transmission planners work together to ensure actionable and realistic long-term plans.

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[12] In general, it is important to note that utilities constantly change tools and often have more than one being used, and all tools need improvements and will be updated accordingly.

[13] I.e., an integrated planning will bring benefits not only to TVA but also to the company's customers.

## Utility Perspective 3: Duke Energy

### *Company Description*

Duke Energy is an electric power and natural gas holding company headquartered in Charlotte, North Carolina. The company's electric utilities serve approximately 8.2 million customers, and it operates primarily through the regulated utilities of Duke Energy Carolinas, Duke Energy Progress, Duke Energy Florida, Duke Energy Indiana, and Duke Energy Ohio/Kentucky, which engage in the generation, transmission, distribution, and sale of electricity across these regions. Collectively the company owns about 50,000 MW of generating capacity fueled from a variety of sources such as hydro, coal, oil, natural gas, and nuclear. The natural gas utility serves 1.6 million customers and distributes natural gas primarily through the regulated utilities of Piedmont Natural Gas and Duke Energy Ohio in North Carolina, South Carolina, Tennessee, Ohio, and Kentucky [13].

### *Duke Energy's Definition of Integrated Planning and Motivation*

Duke Energy's Integrated System and Operations Planning (ISOP) framework [14] originated from the company's climate commitment to reach net-zero carbon by 2050. It was developed to respond to the significant advancements in and growth of distributed energy technologies, system-wide decarbonization, and to address the impacts of climate change.

ISOP involves integration across generation, transmission, distribution and the customer segments, and is a process that aims to address the above-mentioned challenges and create opportunities for a wide range of resources and technologies. ISOP operates across both Duke Energy's vertically integrated and horizontally organized regions. ISOP has required collaboration between the company's long-term, mid-tern, and near-term planners, as well as its strategic teams, and has resulted in new analytical methods to support planning for the company's carbon goals and energy transition. ISOP also has had the responsibility to look at the grid implications of the energy transition and focused specifically on non-traditional solutions such as the potential of storage and non-wires alternatives to support the grid's energy requirements. The main objectives of ISOP are addressing operability of potential resource portfolios when facing rapid renewable growth, enhancing modeling and analytics to assess new technologies, being able to evaluate different portfolio assets across a wide range of uncertain future scenarios, as well as integrating these portfolios with operations.

Duke Energy has been very motivated by this process and considers it as high value for its customers' and the company's future. The company believes that this level of vision and planning is pivotal to remain engaged in the utility business, which has become the expectation of regulators and the company's stakeholders.

### *Framework*

Duke Energy's "enterprise strategy" is a process that occurs every 3 to 4 years at the senior level and at the board level that looks at the company's mission, existing capabilities and gaps, and the evolving regulatory environment. The ongoing process reassesses the company's position, goals, and ultimate objectives; ISOP emerged from one of those assessments to determine how Duke Energy should position itself the future.

ISOP is not yet a formal process, but the framework has been gaining traction at the company, which has been able to organize a team with expertise across domains to support this process. It is organized as shown in Figure 4-4 [15]. Duke Energy has chosen to keep its integrated resource planning, transmission planning, distribution planning, and customer program planning as distinct entities and with a regional presence based on the jurisdictions the company serves. From each of these planning groups, there continue to be a distinct integrated resource plan, transmission asset plan, and distribution asset plan for each region. ISOP is not intended to replace these plans. Instead, the process has been formulated to create the collaboration between these functions and teams, and to help modernize the tools and data systems that the company is currently using. ISOP is working among all these entities to facilitate collaboration within the company and remove the traditional barriers between the silos of generation, transmission, and distribution planning; build data systems appropriate for their use; and develop new tools and methods that are needed to help support them. The diagram shows three new areas that the company decided to invest in:

- "Grid system data" intended to support the integration across all systems.
- "Morecast," an in-house granular circuit-level forecasting tool developed to give hourly (8,760 resolution) forecasts for all the company's distribution circuits (this tool has allowed more visibility of the circuits, and considers net metered solar, distributed resources such as solar PV and batteries, and EV penetration).
- "ISOP data system," which is an integration environment around these tools –an information hub used to move information around and share it between systems.

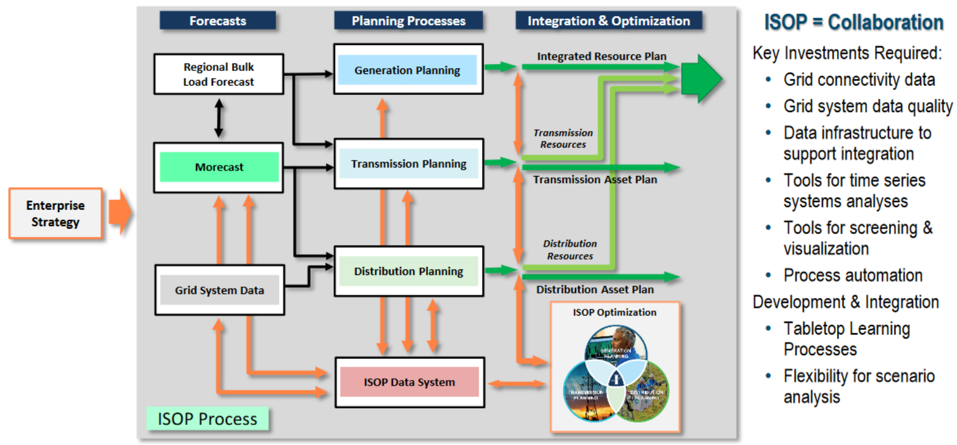


*Figure 4-4*
*Duke Energy's ISOP overview*

Duke Energy has been taking an approach to integration planning that "works from both sides." The company performs a regional bulk system forecast that is fed into generation planning and transmission planning analyses, and also uses it as a framework for detailed circuit level forecasts. At present, generation capacity planning continues to use a top-down load forecast approach. Distribution system planners are transitioning to a bottom-up circuit forecast approach to estimate potential circuits overloads. There is a process to reconcile the top-down and bottoms-up load forecasts. The company is working through a process to better align the information that goes into circuit level forecasting (which has local economic impacts) with transmission level analyses. The green arrows in the diagram reflect the company's expectation of more transmission options, as well as distributed resources and distribution and customer options, as being part of its decision-making process.

### *Implementation*

Duke Energy has been developing the ISOP process for several years. During this time, the company has actively participated in integrated planning activities with EPRI, Smart Electric Power Alliance (SEPA), the NARUC-NASEO task force, among others. The company has also held discussions with other utilities performing integrated planning such as Southern California Edison (SCE), Los Angeles Department of Water and Power (LAPDW), Hawaiian Electric (HECO), Xcel Energy, Dominion Energy, Southern, and DTE Energy.

ISOP is an evolving process which has been building for a few years now. The process started as an initiative with early efforts in 2017 and 2018, before it was formally launched as an organization in 2019. Current focus areas include grid hosting capacity analysis; climate risk and resilience; long-term T/D grid planning; and detailed storage use cases. In terms of frequency, Duke Energy has been updating existing processes and systems annually, driven by the rapid evolution in analytical tools, and emerging trends and stakeholders needs. The company is working with stakeholders and evaluating whether to perform a full ISOP process on a one- or two-year cycle.

Duke Energy initiated its ISOP process in the Carolinas and plans to continue implement it in other jurisdictions. Initial ISOP deliverables are on the company's roadmap for Florida in 2023 and for the Midwest in 2024. The implementation of ISOP in those areas will need to be adjusted to their unique characteristics. For example, Indiana, Ohio and Kentucky are regions impacted by FERC Order No. 2222 (regarding DER aggregation) and are within the MISO and PJM systems, which are the regional grid planners and operators. Duke Energy is in early stages determining how to perform strategic transmission analysis and advanced distribution planning in those jurisdictions.

### *Stakeholder Engagement*

In addition to the internal collaborations between business units, Duke Energy is now interfacing extensively with a large group of external stakeholders, a move that has been new for the company at this level of engagement. These stakeholders vary depending on jurisdiction, and represent a wide range of groups including regulators, public agency staff, customer advocates and organizations, resource developers, industry agencies and consultants, and academic communities. Current stakeholder engagements support activities around IRP, ISOP, grid hosting, climate risk and resilience, and transmission and distribution grid modernization plans.

In general, stakeholder engagements are tailored to the regulatory proceedings that are occurring (e.g., a rate case, a carbon plan, an integrated resource plan), and follow the different timelines of each process. Duke Energy invites stakeholders to each engagement with the objective of integrating input from a diverse range of perspectives. In Duke Energy's environment, many decisions are ultimately made (or approved) either by public service commissions or by FERC, rendering them among the most critical stakeholders.

### *Modeling Tools and Metrics*

Duke Energy uses several analytical tools for performing integrated planning and works closely with its vendors in improving the capabilities of existing tools and developing new tools and processes for advanced planning.

- As data systems are getting bigger and more complex, especially when integrating Advanced Metering Infrastructure (AMI), the company has required an extensive data repository. For this, the company has been using Hadoop and more recently AWS.
- Some of the tools and processes have been developed internally, such as tools used for Morecast, Grid Data Integration, ADP Integration, and the ISOP Data System.

- The company's commercial tools include, but are not limited to, Eaton's CYME, Siemens' PSS®E, Anchor Power Solutions' EnCompass, Hitachi Energy's PROMOD, ABB's PROSYM and SO, and PowerGem's TARA.[14]

In general, the company has made significant investments in the company's own digital transformation team. Duke Energy today is a conglomerate of many mergers and legacy systems. Therefore, one of the first ISOP tasks was to create a consistent system in terms of units of measure, scales, language, and definitions so the utilities could perform accurate analyses and comparisons across the system (this was the backbone of the ISOP Data System). In terms of modeling tools, Duke Energy is enhancing its existing capabilities for more bottom-up approaches to further support developing regional forecasts. Creating forecasts at the circuit level has been a challenge as they need to be accurate enough for planning (especially with distributed energy resources).

There are several outcomes out of Duke Energy's integrated system planning process, which then need to be translated into plans that are both feasible and reliable. Most of Duke Energy's integrated planning processes focuses on metrics for customer costs and reliability (e.g., effective load carrying capability, resource adequacy, extreme events, etc.), which have grown in importance.

### *Challenges*

Duke Energy has overcome many challenges throughout its implementation of ISOP. Overall, there have been internal resource challenges, a lack of existing vendor supported software solutions, disparate legacy systems, and challenges aligning the company's vision. Having a sufficient workforce has been a challenge. Moreover, ISOP has made significant improvements to the planning teams' tools and approaches. The company has worked hard to align terms, definitions, and future perspectives to obtain "buy in" from staff across many business units.

For this purpose, Duke Energy developed a change management process, and used a change management team to help planners. Duke Energy recommends change management experts in supporting major company evolutions, such as transitioning to an integrated system planning process, to ensure that communication is fluid, and that staff receive the necessary training before utilizing new tools and undertaking new tasks.

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[14] It is important to note that utilities frequently change tools, and often use more than one tool. All tools also require improvements and updates, particularly as modeling needs change and the industry continues to transition.

## Utility Perspective 4: Oglethorpe Power Corporation

### *Company Description*

Oglethorpe Power Corporation (OPC) is one of the largest power supply cooperatives in the United States and one of the primary energy producers in Georgia, owned by 38 electric membership corporations (EMCs) that serve approximately 4.4 million customers. Its electric generation portfolio has a combined capacity of more than 8,300 MW, of approximately 19% coal, 57% natural gas, 14% nuclear and 10% hydroelectric power as of 2022 [16].

### *OPC's Definition of Integrated Planning and Motivation*

OPC has a unique structure and therefore does not formally engage in integrated system planning. The company's 38 distribution co-ops members can contract with other service providers in addition to OPC, and consequently OPC is not a full-service provider. In addition, the company only owns and plans for generation, which makes integrated planning across generation, transmission, and distribution challenging.

One aspect of more coordinated planning OPC is embarking on is a closer coordination between itself and the Georgia Transmission Corporation (GTC), which oversees transmission, and the Georgia System Operations Corporation (GSOC), which manages system operations and oversees metering systems and telecommunications. The goal is for the three companies to begin more formally discussing potential long-term implications of carbon policy and other regulations, develop joint scenarios for future planning, and share information to enhance modeling processes. OPC thinks that this emerging process offers real value to its member co-ops, as it will help these EMCs make long-term plans in a fast-changing environment. The company believes that it is well-positioned to perform this type of a long-term, coordinated exercise because of the quality of modeling tools available, as well as the close collaboration it has with GSOC. If members were to have more complete information about the system, then under this integrated arrangement, OPC would be able to perform extensive analyses for all member co-ops and inform them of potential resource adequacy deficiencies or other planning opportunities.

### *Framework*

The collaborative framework between OPC, GTC and GSOC is still emerging and thus, there is no formally defined process yet. The first meeting between the three companies occurred in September 2022, and over the next six months they will be working to define their vision for integrated system planning. In parallel, OPC's planning process already has a defined framework for gathering data, collaborating across business units, acquiring internal and executive reviews, and sharing plans with OPC's board. Outside the company, OPC maintains fluent communication with GSOC as it is a valuable source of information for reviewing data and results of the planning process.

OPC's system planning framework for generation supply is based on economic and statistical modeling and analysis, and the output of that work has traditionally been used as the company's resource plan. Additionally, using information supplied by the EMCs to GSOC and OPC itself, the company performs an annual long-term needs analysis, with a goal of identifying additional generation and the timing for when it is needed. Outside of this process, EMCs may approach OPC to acquire assets, or they can also decide to acquire needed electricity via member scheduling groups.[15]

### *Implementation*

Due to the uniqueness of the three companies collaborating on a more integrated planning approach, there is a paucity of examples from other companies which can directly apply to OPC. However, each of the three companies has enough knowledge about what the other companies do, so they are working to pull information together into a more collaborative process—including the critical piece about what information its EMCs can share. For its traditional resource planning process, OPC has focused mostly on expanding the capabilities of its modeling tools. By working closely with its software vendor, its modeling software has been modified to account for the needs of the company, such as member co-ops supply agreements with third-party power suppliers.

OPC's long-range resource planning efforts fall within the purview of its financial and energy forecasting/planning departments. The data process and analysis require working with consultants and with each of the business units internally, and then sharing it with the operations department before it is reviewed by the executive team. When the process is complete, the company organizes the resulting information into individual reports for the member co-ops. For the evolving collaborative process between OPC, GTC and GSOC, it is the companies' planning departments that have the main role—GSOC's operations and short-term modeling areas, GTC's system transmission planning within its engineering unit, and OPCs' planning area are the key players.

### *Modeling Tools*

For its planning exercise, OPC uses a combination of commercially available software and in-house developed tools, and for data updates the company contracts consulting or engineering groups.

- For load forecasting, OPC developed an in-house excel-based tool that is shared across EMCs. The advantage of this approach is that the EMCs can modify it accordingly to their situations (e.g., customized growth rates, new loads), and then information can be aggregated back up to the OPC system load level.
- For its long-term and short-term economic modeling, OPC relies on a stochastic model used for long-term expansion and for dispatch under

[15] Member scheduling groups (5 in total) make purchases of electricity from power marketers or other sources [26].

different scenarios based on the company's units operating characteristics, contracted data, and internal data.

- Commercial tools include, among others, Abacus[16] Solutions' SATURN. [17]

For the past years, OPC has been working with its main vendor to use new functionalities of the planning tool; incorporate more realistic assumptions about supply contracts, members sales and purchases into and out of the market; and enhance the model's dispatch methodology. One of the main drivers for moving forward with these changes was the high penetration of variable energy resources in OPC's region, and the need for the company to understand potential impacts on the operation of its units. OPC now includes solar resources in the model that considers four to five years of historical weather data and can identify optimal areas for potential solar location.

### *Challenges*

One of the key challenges to implementing OPC's planning processes has been a general lack of resources and time. The company is a very lean organization and there are limited staff working in planning and forecasting, and performing modeling work. Additionally, the long-range financial forecasting process and the budgeting process take substantial time, leaving only a few months each year to work on the planning process itself.

In the case of the emerging, more collaborative process between OPC, GTC and GSOC, the market environment and their unique structures pose a challenge. In this market, generation, transmission, and the operation of the system are functions managed by three different entities, and distribution co-ops may have distinct contract service providers, therefore the collaboration between various entities becomes difficult. For example, one challenge is related to the potential sensitivity of EMCs' scheduling data, and under what conditions these members will share the specifics of their scheduling contracts. A specific modeling challenge OPC sees is in having appropriate tools for performing long-term strategic analysis on both generation and transmission resources simultaneously, among other relevant features of transitioning systems. Another challenge relates to companies needing to find time outside their normal responsibilities to move this process forward and ensure that workload is distributed evenly. More broadly, adapting to the fast pace of change of the industry, and the uncertainty of new legislation and the potential emerging technologies are critical challenges faced by OPC and the industry in general.

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[16] SATURN tool [27].

[17] It is important to note that utilities frequently change tools, and often use more than one tool. All tools also require improvements and updates, particularly as modeling needs change and the industry continues to transition.

## Utility Perspective 5: National Grid

### *Company Description*

National Grid (NG) is an energy company operating in the U.S. and U.K. In the U.S., it is one of the largest investor-owned energy companies, serving more than 20 million people throughout New York and Massachusetts [17]. The company owns and operates electricity distribution networks in upstate New York and Massachusetts, and it also owns and operates electricity transmission facilities across the Northeast (upstate New York, Massachusetts, New Hampshire, and Vermont). The company also owns and operates gas distribution networks across the Northeast [18].

### *National Grid's Definition of Integrated Planning and Motivation*

For National Grid, integrated system planning is led by an engineering liaison group that integrates planning and other core activities across the company. This provides planners with an end-to-end understanding of other functions (e.g., regulatory, pricing, operations, gas, IT), and helps them make informed decisions regarding the company's projects. National Grid considers integrated planning to serve three main functions:

- First, it bridges the gap and creates a bi-directional flow of information between planning and the rest of the company. This is probably the most important function, as the planning voice is now heard in other efforts and departments across the company (for example, when developing EV and clean heat incentives to support the energy transition). NG believes it is critical for planners to be aware of these activities, and make sure that when there is a proposal for developing incentives, for example, they are in the room to explain the impacts of those changes and the requirements needed for the implementation.
- Second, integrated planning develops processes, and an approach to evaluate new technologies and methods, such as non-wires alternatives, EVs, charging programs, and demonstration and pilot projects.
- Third, integrated planning guides and coaches individuals throughout the company. It integrates best practices into planning, and it guides planners on new tools and methods to ensure that system reliability is maintained.

National Grid believes that integrated planning is crucial to keeping the clean energy transition affordable and reliable. If companies are not co-optimizing their systems (e.g., gas and electric transmission distribution, IT), and continue making decisions in a siloed manner, they are likely leaving efficiencies on the table. Integrated planning seeks the most efficient way to meet all area needs over necessary long-time horizons.

### *Framework*

National Grid does not have a formal structure to its integrated planning process. Adaptability is key to the company, so it has adopted a more incremental approach that evolves and respond as the company proceeds with its planning exercises, and it is iterative in nature. There is, however, a framework in place to help the company approach problems and think about end-to-end optimization.

The company's integrated planning lives between systems' boundaries. For instance, Advanced Metering Infrastructure (AMI) is used to understand customer behavior and inform load forecasts. In the distribution and transmission interface, the company ensures that DER forecasts are built into transmission studies. In the gas and electric interface, NG evaluates opportunities to electrifying heating in regions with electric capacity. In the IT and the business/control center, integrated planning supports the integration of power flow tools in the control center such as Advanced Distribution Management System (ADMS) and Distributed Energy Resource Management System (DERMS).

This process has been supported by a collaborative environment and benchmarking with other companies. In the first case, the Joint Utilities of New York [19] (which collaborates with the Public Service Commission and the New York Independent System Operator, NYISO) has facilitated engagement between New York utilities with regular meetings to discuss state policy goals and respond to the Commission proceedings, with an emphasis on distribution-connected energy resources and the transition to clean energy in the state.[18] In the second case, the company recently acquired Western Power Distribution based in the U.K. (now National Grid Electricity Distribution) which has broadened the company's experience with enabling the clean energy transition through integrated system planning [20].

### *Implementation*

Pace is critical to NG in its implementation of integrated planning. The company has adopted an incremental approach, where they take one step at a time and attempt a solution that will provide the company benefits in the near term. This means integrated planners adopt practices that they see immediate value in (i.e., learning and adapting in real time). NG considers this to be an agile approach to implementing solutions focused on flexibility, and it is expected to improve the company's ability to adapt to disruptive technologies and changing environments. This contrasts with a more traditional planning approach of analyzing the end-state in-depth, which could result in burdensome analysis with limited value given future uncertainties surrounding the clean energy transition.

[18] Most of National Grid's involvement with NYISO is related to dual participation –resources that participate in both wholesale and retail markets but also serve grid needs, like a non-wires alternative (NWA). In addition, NG's integrated planning, if needed, would also support the development of new planning processes involving NYISO (such as the Coordinated Grid Planning Process in NY).

For example, when procuring new planning tools, NG will procure modules one at a time, building and learning as it goes (as opposed to procuring a complete tool all at once).

The frequency of the integrated planning process is ad-hoc, as the company develops several processes based on the needs it faces. One example of a recently completed activity is a non-wires alternative (NWA) analysis, which the company developed a process to evaluate projects under a cost-benefit analysis framework. This included the bidding process, procurement, project approval and sign off, cost recovery evaluations, and accounting. Another example is NG's ongoing initiative of integrating gas and electric system planning. This work focuses on determining the needs of both systems jointly, for example how forecasts of gas and electric heating should be shared or how either system could support a constrained area of the other. Each of these processes are frequently reviewed and updated (typically at least two years, or when there are policy changes).

### *Stakeholder Engagement*

Internally, NG's integrated planning process involves several business units, including the planning, operations, finance, procurement, and regulatory groups, among others. The processes in place are bi-directional, where planning and operations needs are translated and passed to the other units, and information and data come to planning and operations in a manner that the analytical models can easily use them.

Externally, NG engages with regulators, DER developers, and other stakeholders involved in the clean energy transition; the company regularly participates in conferences and consortiums (such as NY-BEST[19]); and it also informs and educates stakeholders across the industry. These efforts are important for NG, especially as the company considers external stakeholders capable of appreciating technical aspects of the planning process. The company also regularly requests feedback from its stakeholders. For example, EV vendors that will be involved with EV highway planning collaborate with NG planners through an iterative process because each party needs to understand how the other operates to maximize planning efficiencies.

### *Modeling Tools*

The company uses several tools to perform integrated planning around various types of analysis on distribution feeders, transmission networks, load-flow, short-circuit and protection studies, and for coordinated planning of the electric and gas transmission and distribution infrastructure.

- In addition, the company uses Geographic information system (GIS) for mapping and analyzing data.

[19] New York Battery and Energy Storage Technology Consortium [28].

- Commercial tools include, among others, encoord's SAInt software[20], Eaton's CYME, Siemens' PSS®E, and ASPEN's OneLiner.[21]

### Challenges

As National Grid works toward a clean, equitable, reliable, and affordable energy system, it faces numerous challenges. Rapid and frequent changes in policy drive customer decisions (e.g., replacing gas heating with electric heat pumps) which will bring substantial changes to the existing electric power system (e.g., moving from a summer peak to winter peak). For National Grid, understanding customer decisions is critical from a load and generation forecasting standpoint (particularly when it comes to PVs, EVs and heat pumps if driven by regulatory policy) and it expects to influence those decisions through signals that show where there is planning value. At NG there are entire teams supporting energy efficiency and demand response who seek to understand the changes in and the drivers of customer behaviors. Other challenges the company currently faces also includes an aging T/D system in NY and New England. In the former, NG recognizes that active distribution network planning and operation might be needed to manage these loads. Regarding non-traditional load growth, the company seeks to plan proactively to replace assets throughout the system, while identifying opportunities for multi-value improvements.

[20] See https://www.businesswire.com/news/home/20221129005030/en/National-Grid-licenses-encoord%E2%80%99s-SAInt-software-for-integrated-planning.

[21] In general, it is important to note that utilities constantly change tools and often have more than one being used, and all tools need improvements and will be updated accordingly.

# Section 5: Concluding Remarks

This report describes how electric companies are currently applying or beginning to apply methods for integrated system planning (ISP) to support their resource planning processes and goals. It considers perspectives from of a wide range of utility types, considering their specific structures and market environments.

The company summaries in this report highlight a notion that integrated system planning is often seen as a key to support transitioning to a cleaner, lower-carbon energy future in an affordable and reliable manner, while simultaneously meeting companies' long-term objectives. Decarbonization is seen as one of the main drivers for engaging in integrated system planning, as the transition to lower-carbon portfolios will result in more complex power systems. This expected complexity is fueling the need for new methods and analytical tools, and more tightly integrated processes within and across organizations. Each company interviewed in this paper recognized that there is value in closer collaboration across generation, transmission, and distribution and consumer-sided resources, and in understanding how to optimize a more coordinated system to reduce costs.

However, market environments and companies' unique structures add complexity to an ISP process, and collaboration and coordination across generation, transmission, and distribution may be challenging. Therefore, the approaches that utilities are adopting for ISP implementation are diverse. Based in the interviews, we note that,

- For vertically integrated utilities, the integration process has relied on aligning inputs and assumptions across all planning activities and increasing coordination across all business units—an iterative process that shares results between forecasting, G/T/D, as well as customer programs. For one company, the process has entailed reconciling top-down and bottom-up approaches used for generation and transmission planning, and for distribution planning respectively.
- For a G/T utility, the integrated planning process has focused first on the G/T interface and on the new processes needed to enable the co-optimization of transmission and generation resources. The T/D interface has relied on understanding the planning and reliability needs of distribution utilities partners, and how to formally integrate them into the broader planning exercise.
- For a G-only utility, a more coordinated integrated planning across G/T/D is challenging, although there is recognition that integrated planning

processes can be valuable, depending on the type of information that can be shared across the distinct companies and the level of collaboration that can be achieved.

- For a T/D utility, the integrated planning process has been prioritizing T/D planning needs with focus on non-wire alternative solutions as well as more accurate end-use forecasting, and with transmission planning closely coordinated with the regional system operator.

The report shows that companies have made significant investments to enable digital environments that manage and integrate large data sources and modeling capabilities. The need for advanced and more flexible modeling tools has driven companies to acquire new software and enhance current analytical tools, many times collaborating with software vendors to enable functionalities for advanced planning. Organizations are creating new interfaces to handle data transfer and processing across different, previously siloed functions.

Each ISP process described in this report has a very involved stakeholder and customer engagement process, with different touch points to meet with them and ensure they provide necessary input. The motivation for engaging external stakeholders goes beyond transparency; it is about understanding what customers need and setting planning priorities accordingly. Companies engage extensively with large group of stakeholders, which may be different depending on the jurisdiction and represent a wide range of groups, including regulators and government officials, customer advocates and organizations, resource developers, manufacturers, trade organizations, consultants, academics, and nonprofit organizations.

Companies have experienced a wide range of challenges as they have begun to implement integrated planning approaches. Internal challenges have included resource constraints, workforce constraints, immature or emerging methods and software, disparate legacy systems, a need for more alignment across business units around company vision, change management, and communication. Determining ways to support the new processes that ISP creates, without conflicting with near term needs, has been also recognized as a challenge.

Finally, given the still emerging nature of the topic, continued communication within the industry about utility experiences and lessons learned with integrated planning, including having a common platform to facilitate further exploration and wider discussions will be critical. Road mapping and pilot projects to examine, in detail, key elements of an ISP that could be used in practice to enhance existing planning processes will also be an important next step for electric utilities interested in engaging in more coordinated planning practices.

# Section 6: References


1. *EPRI Integrated Strategic System Planning Initiative: Demonstration Study Modeling Results & Key Insights* (forthcoming), 2023.
2. *Developing a Framework for Integrated Energy Network Planning (IEN-P): 10 Key Challenges for Future Electric Resource Planning*, EPRI, Palo Alto, CA: 2018. 3002010821.
3. Salt River Project (SRP), "Our power generating stations and plants in Arizona | SRP," 2022. https://www.srpnet.com/grid-water-management/grid-management/power-generation-stations (accessed Oct. 25, 2022).
4. Salt River Project (SRP), "SRP Integrated System Plan Technical Working Session: Study Plan Details," 2022. Accessed: Nov. 09, 2022. [Online]. Available: https://www.srpnet.com/assets/srpnet/pdf/grid-water-management/grid-management/isp/ISP-technical-working-session-1-presentation.pdf.
5. National Association of Regulatory Utility Commissioners (NARUC), "Task Force on Comprehensive Electricity Planning - NARUC," 2022. https://www.naruc.org/taskforce/ (accessed Oct. 25, 2022).
6. National Renewable Energy Laboratory (NREL), "LA100: The Los Angeles 100% Renewable Energy Study," Golden, CO, 2021. Accessed: Oct. 25, 2022. [Online]. Available: https://www.nrel.gov/analysis/los-angeles-100-percent-renewable-study.html.
7. Duke Energy, "Integrated System & Operations Planning (ISOP)," 2022. https://www.duke-energy.com/our-company/isop (accessed Oct. 25, 2022).
8. Salt River Project (SRP), "Summary Study Plan for SRP's Integrated System Plan," 2022. Accessed: Oct. 25, 2022. [Online]. Available: https://www.srpnet.com/assets/srpnet/pdf/grid-water-management/grid-management/isp/SRP-ISP-Summary-Study-Plan.pdf.
9. Tennessee Valley Authority (TVA), "Energy," 2022. Accessed: Oct. 25, 2022. [Online]. Available: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/annual-report/fact-sheets/energy11782fe3-e859-4437-bfb3-61874200b4d1.pdf?sfvrsn=c44bcc75_3.
10. Tennessee Valley Authority (TVA), "Board of Directors," 2022. https://www.tva.com/about-tva/our-leadership/board-of-directors (accessed Oct. 25, 2022).

11. Tennessee Valley Authority (TVA), “2019 IRP Near-term Action Update,” 2020. Accessed: Nov. 10, 2022. [Online]. Available: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/environmental-stewardship/integrated-resource-plan/2019_irp_nearterm_action_update_final_120820-1.pdf?sfvrsn=79ac8e7_2.

12. Tennessee Valley Authority (TVA), “Regional Energy Resource Council,” 2022. https://www.tva.com/about-tva/our-public-advisory-councils/regional-energy-resource-council (accessed Nov. 22, 2022).

13. Duke Energy, “About the Company,” 2022. https://www.duke-energy.com/our-company/about-us (accessed Oct. 25, 2022).

14. Duke Energy, “Integrated System & Operations Planning (ISOP),” 2022. https://www.duke-energy.com/our-company/isop (accessed Oct. 25, 2022).

15. Duke Energy, “Duke Energy Integrated System and Operations Planning (ISOP) Virtual Forum,” 2021. https://p-scapi.duke-energy.com/-/media/pdfs/our-company/isop/isop-virtual-forum-2021-07.pdf?_gl=1*p0bzfo*_ga*NTUxNDUzNzk0LjE2NTQwMjM1Mzc.*_ga_HB58MJRNTY*MTY2NjYyNjU3OC4yMC4xLjE2NjY2MjY1NzguMC4wLjA (accessed Oct. 25, 2022).

16. Oglethorpe Power Corporation, “Where Power Originates,” 2022. https://opc.com/where-power-originates/ (accessed Oct. 25, 2022).

17. National Grid USA, “Our Company | National Grid,” 2022. https://www.nationalgridus.com/Our-Company/ (accessed Oct. 25, 2022).

18. National Grid USA, “What we do | National Grid Group,” 2022. https://www.nationalgrid.com/about-us/what-we-do (accessed Oct. 25, 2022).

19. The Joint Utilities of New York, “About the Joint Utilities of New York | Joint Utilities,” 2022. https://jointutilitiesofny.org/about/who-we-are (accessed Oct. 25, 2022).

20. National Grid, “Repositioning National Grid’s portfolio | National Grid Group,” 2022. https://www.nationalgrid.com/repositioning-national-grids-portfolio (accessed Oct. 25, 2022).

21. Arizona Corporation Commission (ACC), “Electric Frequently Asked Questions | Arizona Corporation Commission,” 2022. https://azcc.gov/utilities/electric/electric-faqs (accessed Oct. 25, 2022).

22. Salt River Project (SRP), “Integrated System Plan (ISP) | SRP,” 2022. https://www.srpnet.com/grid-water-management/grid-management/integrated-system-plan (accessed Oct. 25, 2022).

23. Salt River Project (SRP), “SRP Integrated System Plan, Modeling Subgroup: Integrated System Plan Modeling Ecosystem,” 2022. Accessed: Oct. 25, 2022. [Online]. Available: https://www.srpnet.com/assets/srpnet/pdf/grid-water-management/grid-

management/isp/ISP_AG_Optional_Modeling_Subgroup_Meeting_1_Slide_Deck.pdf.

24. Salt River Project (SRP), "SRP Integrated System Plan, Modeling Subgroup Meeting #2: Inputs for the ISP Study Plan," 2022. Accessed: Oct. 25, 2022. [Online]. Available: https://www.srpnet.com/assets/srpnet/pdf/grid-water-management/grid-management/isp/ISP_Advisory_Group_Modeling_Subgroup_Slide_Deck.pdf.
25. Tennessee Valley Authority (TVA), "Regional Grid Transformation," 2022. https://www.tva.com/energy/technology-innovation/regional-grid-transformation (accessed Nov. 13, 2022).
26. Georgia System Operations Corporation, "Georgia System Operations: How does GSOC support generation?," 2022. https://www.gasoc.com/generation/Pages/generation.aspx (accessed Oct. 25, 2022).
27. Abacus Solutions Inc., "Abacus SATURN," 2022. http://www.abacussolutionsinc.com/saturn.html (accessed Oct. 25, 2022).
28. New York Battery and Energy Storage Technology Consortium, "Our Story," 2022. https://ny-best.org/page/AboutNYBEST (accessed Oct. 25, 2022).

# Appendix A: Discussion Questions

The material presented in the utility perspectives section was taken from interviews conducted between June and September 2022 with each electric company around their specific system planning processes. The interviews used the discussion questions outlined below, which were subdivided into general discussion topics and a set of more specific questions.

## General Topics

1. Does your company engage in an integrated system planning process? If the answer is no, do you see any value in integrated system planning now or in the future?
2. What is your definition of integrated system planning?
3. Why is ISP important for your company? What is the value provided versus cost of engaging in such a process?
4. What are the main drivers for engaging in such a process?
5. What are the main objectives of ISP?

## Specific Topics

1. Is there a defined framework that the company follows?
2. What sources/information have you relied on to learn about and begin implementing integrated planning?
3. What is the duration and timeline of the process?
4. What is the frequency of the process? Does ISP change over the years?
5. Who is involved in the process and what are their roles? (e.g., company business units, external stakeholders?)
6. If possible, could you specify the tools and/or models/software the company uses for integrated planning?
7. What are the expected outcomes of the process?
8. What are the main metrics used to measure those outcomes?
9. How are the outcomes implemented?
10. What challenges or barriers have you faced during the process?

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