DEVELOPING A FRAMEWORK FOR INTEGRATED ENERGY NETWORK PLANNING (IEN-P)

Executive Summary

10 KEY CHALLENGES FOR FUTURE ELECTRIC SYSTEM RESOURCE PLANNING

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THE ELECTRIC POWER RESEARCH INSTITUTE (EPRI) PREPARED THIS REPORT.

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In addition, we appreciate the valuable insights gained from discussing this material with EPRI's Advisory Council (comprised of senior external advisors from academia, state public utility commissions, environmental organizations, and financial institutions), EPRI's Research Advisory Committee (comprised of senior executives and staff from EPRI member companies), and members of EPRI research Program 178: Integrated Energy Planning, Market Analysis and Technology Assessment.

[1] Includes staff from research program on Integrated Energy Planning, Market Analysis and Technology Assessment (178).

[2] Includes staff from research programs on Transmission Operations (39); Transmission Planning (40); Bulk Power System Integration of Variable Generation (173); Integration of Distributed Energy Resources (174); Understanding Electric Utility Customers (182); and, Distribution System Operations and Planning (200).

EXECUTIVE SUMMARY

The fundamental goal of electric company resource planning traditionally has been to develop a least-cost portfolio of electric power resources, including both supply-side (that is, generation) and demand-side resources, that can be used to meet expected peak customer electricity demand plus a planning reserve margin within a defined geographic region over a specified planning time period (for example, 5–20+ years). This approach has been used to plan expansion of electric power systems for more than three decades. Although roles and responsibilities for conducting assessments have evolved in some locales as regional electricity markets have emerged (for example, ISOs and RTOs in the United States), the fundamental goal of planning has remained largely unchanged. More than 30 states require electric companies to develop Integrated Resource Plans (IRPs) or similar documents, and many of the remaining states require electric utilities to do some form of resource planning to demonstrate that company investment plans to meet electricity demand are in the public interest.

In recent years, the electric power industry has undergone a dramatic transformation that is expected to continue and accelerate. This transformation is driven by a variety of factors, including rapid deployment of large-scale variable renewable energy resources (VER) and distributed energy resources (DER); dramatic advances in digital energy and communications technologies that spur increasing customer choice and control; persistent low natural gas prices and increased reliance on just-in-time delivery of natural gas to support gas-fired generation (in some regions); increased awareness of potential high-impact, low-frequency (HILF) events that may disrupt electricity service over wide areas; and growing awareness of the electric sector's potential role in achieving environmental and other broad, societal goals (EPRI describes this future at http://ien.epri.com).

Where some or all of these changes are occurring, traditional resource planning methods may no longer be sufficient to efficiently develop a safe, reliable, affordable, and environmentally responsible power system. A threshold issue is maintaining system reliability. For more than a century, the vast majority of electricity was produced from large rotating machinery, which inherently provided a range of services that kept the overall power system running. As VER and DER displace more traditional synchronous generation—and as customers become more active consumers and producers of energy—planning increasingly will need to explicitly consider the characteristics of supply-side and demand-side options to choose systems that maintain reliability. The focus on reliability will transition from a focus on meeting peak demand to developing a more flexible system that can balance an expanding set of supply and demand resources with continuously changing electricity loads. Another significant change is geographic scope. Renewable resource quality varies widely by region. Given the variation in regional resources and the variability of output, there can be significant economic advantage to analyzing broader geographic areas. In addition, long-term fuel price and energy policy uncertainty, coupled with the needs to reduce environmental impacts and withstand or recover quickly from HILF events, will require new attributes—such as resiliency, flexibility, and sustainability—to be explicitly included in the resource planning processes.

Goals

This EPRI white paper identifies the key resource planning challenges and associated operational issues that increasingly could be faced by electric companies in a rapidly evolving future that includes large-scale VER and DER deployment and expanded customer choice. We aim to communicate both the magnitude of these planning challenges and the challenge of developing and implementing new, more holistic approaches to electric resource planning, while recognizing that each locale will have specific options and needs. This paper also identifies resource planning capabilities and processes we believe need to evolve to address these critical planning challenges. Finally, we have identified key research gaps to be addressed to develop a new Integrated Energy Network Planning (IEN-P) Framework.

Audience

This paper can inform electric system planners, state public utility commission (PUC) and related regulatory staff, and others interested in the future evolution of the electric sector and related infrastructure. Although the United States is the primary geographic focus of this paper, the challenges described should be relevant and valuable to international audiences.

10 Key Resource Planning Challenges

This white paper highlights 10 complex, large-scale challenges electric power system planners and regulators are beginning to confront today and that are expected to become more pressing and widespread. It describes the ways in which traditional electric sector resource planning will need to evolve so that electric companies, regulators, and other stakeholders can effectively address these emerging challenges and benefit from new opportunities arising from the ongoing transformation of the electric sector. It describes needs for new methodologies and functionality, new planning processes, and organizational changes that may be needed to continue to develop robust plans that provide safe, reliable, environmentally responsible, and affordable electric service that also is resilient and flexible.

The 10 critical resource planning challenges are interrelated and can be introduced and grouped in various ways. They are organized for clarity of communication into three groups: 1) modeling the changing power system, 2) integrating forecasts, and 3) expanding planning boundaries. The specific order of the challenges shown next and described in this report does not imply relative importance. System planning is inherently a local activity. The key challenges planners face today—and may face in the future—certainly will vary by geographic region and jurisdiction. Not all of these challenges will need to be addressed immediately or simultaneously. The specific challenges, and the approaches and timing with which to address them, will depend on the specific issues faced by each electric company and jurisdiction.

- **Modeling the changing power system:**

1. **Incorporating operational detail.** As emerging power system resources (primarily solar and wind) replace synchronous generators (for example, coal, natural gas, and nuclear) that traditionally have provided needed operational reliability services, resource planners will need to explicitly consider operational reliability capabilities of candidate resources and methods to mitigate potential impacts.
2. **Increasing modeling granularity.** Computer models for conducting long-range resource planning need to include finer geographic resolution and temporal granularity to address new resource planning challenges.
3. **Integrating generation, transmission, and distribution planning.** Future resource planning will benefit from closer interaction of planners across the entire electricity supply chain to understand how decisions at one planning level may impact other levels as well as the ability to make trade-offs between potential investments in each of these subsystems to optimize the future overall electric power system. Closer integration—driven by value—reverses the recent trend to separate generation, transmission, and distribution planning to promote a competitive environment.
4. **Expanding analysis boundaries and interfaces.** Electric companies are beginning to be asked by regulators and external stakeholders to address issues outside of their electric service territories and in other parts of the economy as part of their resource planning activities. Efficient electrification of end-use sectors—such as transportation, in which electricity historically has played little role—will further expand these boundaries.
5. **Addressing uncertainty and managing risk.** There is a growing need for resource planners to account more explicitly for key uncertainties when developing resource plans and to adopt new approaches for managing evolving corporate risks.

- **Integrating forecasts:**

  6. **Improving forecasting.** Improved and more granular forecasting is critical for robust long-term resource planning. More accurate forecasts of electric load, VER production, DER adoption, future natural gas prices, and weather are high priorities.

  7. **Improving modeling of customer behavior and interaction.** Robust system planning in the future will need to incorporate deeper understanding of electric customer behavior, incentives to change customer behavior, and how customer behavior may impact the performance of emerging customer resources for energy supply, storage, and demand.

- **Expanding planning boundaries:**

  8. **Incorporating new planning objectives and constraints.** Future resource plans will need to be optimized to achieve objectives beyond traditional least-cost resource adequacy—including resiliency, flexibility, and new environmental and societal objectives—while adhering to system operational reliability constraints.

  9. **Integrating wholesale power markets.** Increasingly, planners will need to consider the evolution of wholesale power markets that provide opportunities for companies to buy and sell energy, capacity, and ancillary services along with the impact of these markets on the economic viability of resources that provide reliability services and other desired system attributes.

  10. **Supporting expanded stakeholder engagement.** In recent years, public involvement in company resource planning has increased dramatically. Electric utilities are engaged now more than ever in designing extensive stakeholder engagement processes related to resource planning and responding to stakeholder comments.

Value of This Paper

This paper and the future IEN-P Framework can provide value to electric companies, state regulators, and other entities engaged in planning the future evolution of the electric sector. It communicates the drivers and strong needs for increased communication and coordination along the electricity supply chain and among the multiple industries that are becoming more interdependent with the electric sector every day.

For electric companies, this paper provides a common vision for the multiple internal company planning groups that often operate independently and may not routinely communicate and coordinate their activities. It identifies key resource planning challenges to focus future corporate action and resource planning efforts, and it can be used to identify and prioritize future internal and external research and development (R&D) efforts. Although Integrated Resource Planning (IRP) has been done by regulated electric utilities for many years, we envision the future planning paradigm discussed here to be of value to regulated and unregulated electric companies alike as they address their future planning needs. Company leadership and staff can use it to frame key resource planning issues when communicating with internal company stakeholders, state regulators, and other external stakeholders.

For regulators, this paper can provide a more comprehensive understanding of the key planning challenges facing electric company resource planners and company leaders. It can be used to identify and prioritize future R&D efforts and to communicate the challenges facing electric system planners with external stakeholders.

Learning and EPRI Engagement Opportunities

Many companies and researchers are beginning to grapple with these challenges. Some efforts are documented publicly in IRPs, some are in the peer-reviewed scientific literature, and many are in development.

Many parts of EPRI are making progress in addressing the 10 key challenges. Research to address the planning challenges described in this paper is being conducted in individual EPRI programmatic research areas (typically, research focused on particular types of assets or functions within utilities), including the following:

- Electric Transportation (Program 18)
- Transmission Operations (Program 39)
- Transmission Planning (Program 40)
- Flexible (Nuclear) Operations (Program 41.11.01)
- Water Availability and Ecological Risk (Program 55)
- Fossil Fleet for Tomorrow (Program 66)
- Energy Storage and Distributed Generation (Program 94)
- End-Use Energy Efficiency and Demand Response (Program 170)
- Bulk System Integration of Variable Renewable Resources (Program 173)
- Integration of Distributed Energy Resources (Program 174)
- Integrated Energy Planning, Market Analysis, and Technology Assessment (Program 178)
- Understanding Electric Utility Customers (Program 182)
- Renewable Generation (Program 193)
- Strategic Sustainability Science (Program 198)
- Electrification for Customer Productivity (Program 199)
- Distribution System Operations and Planning (Program 200)
- Energy, Environmental, and Climate Analysis (Program 201)

In addition, EPRI's Technology Innovation (TI) program has several cross-cutting research efforts underway that aim to integrate across company and EPRI program areas, ranging from modeling- and process-focused efforts to link generation, transmission, and distribution planning; efforts to incorporate operational detail in longer term planning; and research to broaden the scope of planning.

Readers who may be interested in engaging with EPRI to address these issues should connect with an appropriate research program listed previously and in Appendix A or contact one of the authors of this report. Also, you can learn more online about EPRI's Annual Research Program. The challenges facing planners today are unparalleled—but equally so are the potential value and opportunities associated with conducting resource planning in a more integrated manner as described in this paper.

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