Opportunities for Integrating Electric and Gas Planning

Authors
LeBel, Mark
Sandoval, Ronny
Frick, Natalie Mims
et al.

Publication Date
2025-01-06

Energy Markets & Policy
BERKELEY LAB

Opportunities for Integrating Electric and Gas Planning

Mark LeBel, Regulatory Assistance Project
Ronny Sandoval, Regulatory Assistace Project
Natalie Mims Frick, Berkeley Lab
Jeffrey Deason, Berkeley Lab

January 2025

This work was supported by the U.S. Department of Energy's Office of Policy under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231.

Opportunities for Integrating Electric and Gas Planning

Prepared for the
U.S. Department of Energy
Office of Deployment and Infrastructure Policy

Authors
Mark LeBel, Regulatory Assistance Project
Ronny Sandoval, Regulatory Assistance Project
Natalie Mims Frick, Lawrence Berkeley National Lab
Jeffrey Deason, Lawrence Berkeley National Lab

Ernest Orlando Lawrence Berkeley National Laboratory
1 Cyclotron Road, MS 90R4000
Berkeley CA 94720-8136

January 2025

The work described in this study was funded by the U.S. Department of Energy's Office of Policy under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231.

Acknowledgements

The work described in this study was conducted at Lawrence Berkeley National Laboratory and supported by the U.S. Department of Energy Office of Policy under Contract No. DE-AC02-05CH11231. We thank Paul Donohoo-Vallett, John Agan, Noel Crisostomo, Glenda Oskar, and Jason Frost for their support of this work.

The authors thank the following experts for reviewing this report (affiliations do not imply that those organizations support or endorse this work):

Kiera Zitelman, Technical Director, National Association of Regulatory Utility Commissioners
Dr. Tera Dornfeld, Regulatory Analyst, Minnesota Public Utilities Commission
James Van Nostrand, Chair, Massachusetts Department of Public Utilities
Justin Gundlach, Senior Advisor for Policy Implementation, New York Department of Public Service
P.J. Martin, Area Vice President, Integrated System Modeling & Analytics, Xcel Energy
Abigail Anthony, Commissioner, Rhode Island Public Utilities Commission
Todd Bianco, Chief Economic and Policy Analyst, Rhode Island Public Utilities Commission
Jessica Shipley, Pacific Northwest National Laboratory
Dr. Long Lam, Managing Energy Associate, The Brattle Group
Josh Figueroa, Senior Associate, The Brattle Group
Dr. Dean Murphy, Principal, The Brattle Group
Karsten Barde, Director of US Policy and Strategy, National Grid
Glenda Oskar, Economist, US Department of Energy, Office of Policy
John Agan, Policy Analyst, US Department of Energy, Office of Policy

Table of Contents

Table of Figures

List of Tables

Executive Summary

Growing demand for electricity in buildings is creating new opportunities and challenges for electric and natural gas planning. To date, processes for planning electricity and gas delivery have largely been siloed, and only a few jurisdictions have started to examine how these two processes could be linked together. There are many potential benefits of integrating these processes, such as:

- Fewer redundant investments
- More affordable bills
- Increased reliability
- Greater confidence in utility decision-making
- More efficient administrative processes
- Cost-effective compliance with public policy requirements.

However, integrating electric and gas planning will require a range of reforms to address challenges with existing planning processes.

This report explores the current state of electric and gas system planning and the benefits and challenges of integrating these planning processes. We frame the characteristics of an integrated electric and gas planning process and identify indicators of progress toward the characteristics, as shown in Table ES-1 on next page.

For each indicator, there are different options for implementation depending on the context and needs of a specific jurisdiction. Potential reforms include:

- Cross-functional teams at dual-fuel utilities and public utility commissions
- Communications mechanisms between utilities with overlapping service territories and methods for sharing data between utilities and with stakeholders
- New processes to ensure coordinated forecasts, as well as to improve data inputs and modeling approaches
- Joint assessment of electric and gas system impacts and costs, either using an integrated analytical approach at dual-fuel utilities or leveraging the full array of integrated planning characteristics for single-fuel utilities with overlapping service territories
- Improved planning outputs to aid procurements and other regulatory efforts.

The pace of change will likely depend on a jurisdiction's priorities and policy goals, but thoughtful attention to these issues and reasonable foresight of coming trends should be helpful in all jurisdictions. For example, initiating a commission docket to explore current practices and barriers to electric and gas planning integration may be an appropriate next step in many jurisdictions. In addition, smaller steps can likely be taken in each planning silo in advance of more comprehensive integration reforms. As electrification trends accelerate, integrated electric and gas planning will better accommodate changes and promote cost-effective investment patterns to ensure that all customers receive reliable and affordable energy in coming decades.

Table ES-1. Characteristics of Integrated Electric and Gas Planning and Indicators of Progress

Characteristics	Indicators
Improved organization, communications and collaboration	• Integration across internal organizational silos • Effective data sharing • Mechanisms for education, collaboration and stakeholder input
Aligned inputs for forecasting and modeling	• Consistent and aligned forecasts and inputs across proceedings • Best available data inputs and up-to-date modeling techniques
Reformed analytical structure	• Improved sequencing and coordination of utility filings • Joint assessment of electric and gas system impacts and costs
Sufficient outputs for procurements, programs and other processes	• Planning data used to structure multifuel procurements and improve customer programs • Planning data and analysis used to improve cost allocation • Combined customer data used to improve affordability programs

1. Introduction

For the last four decades, utility planning has continuously evolved across the United States in response to new technologies, cost trends, and public policies. In the 2020s, demand is growing for electrification of end uses in buildings that traditionally have been powered directly by fossil fuel combustion. These end uses include space and water heating, as well as smaller fuel market segments such as cooking. Substitution of efficient electric end uses for existing natural gas end-uses has simultaneous effects on both the electric and gas systems, creating a growing interest from public utilities commissions in integrating electric and gas planning processes to achieve efficient, affordable and consistent outcomes.

To date, electric and gas planning processes have largely been siloed, and only a few jurisdictions have started to examine how these two processes could be linked together.[1] Integration can allow for joint optimization of electric and gas system investments, as well as multi-fuel procurements[2] and improved program implementation. Potential benefits include fewer redundant investments, more affordable bills, decreased reliability risks, and more efficient administrative processes. However, integrating electric and gas planning will require a range of organizational and procedural reforms, especially in areas that are served by separately-owned electric and gas utilities. While some aspects of integrated electric and gas planning will require innovative approaches, policymakers can build upon previous planning reforms as a starting point for integration and as a model for certain concepts.

This report seeks to advance public utility commission, utility, and stakeholder thinking on the challenges and solutions to integrating electric and gas planning. Based on a review of existing literature, current planning practices, and selected interviews with state regulatory commission staff, we identify the characteristics of an integrated electric and gas planning structure, discuss the benefits of this structure, and provide a set of actions states can take to achieve integration.

The remainder of the report is organized as follows. Section 2 provides background on electric and gas planning, including typical approaches to planning, the structure of electric and gas service territories, and recent developments. Section 3 describes potential benefits and challenges of integrating electric and gas planning that regulators must consider. Section 4 identifies the characteristics of an effectively integrated electric and gas planning process and describes how those characteristics are connected to improved outcomes. Section 5 discusses implementation actions and examples for jurisdictions to consider when seeking to achieve more integrated planning. Section 6 provides concluding thoughts and discusses how individual jurisdictions can start to make progress on these issues.

---

[1] This paper focuses on how best to adapt utility planning processes in the face of electrification and the potential for significant switching from natural gas to electricity for certain end-uses. However, there has been a separate set of discussions around reforms to address the reliance of the electric system in many places on the bulk natural gas transmission system. On the latter set of issues, which are not addressed in this paper, the National Association of Regulatory Utility Commissioners (NARUC) created the Taskforce on Gas-Electric Alignment for Reliability in 2023: https://maxxwww.naruc.org/forms/committee/CommitteeFormPublic/viewExecCommittee?id=13B6350000001C&multicolumns=1

[2] We adopt the term "multi-fuel procurements" because there are options in addition to electric and gas resources in many cases. For example, thermal energy networks are an emerging option for customer heating and cooling, described further in Section 2.4.

2. Background on Electric and Gas Planning

When contemplating the integration of electric and gas planning, it is important to understand where state-level electric and gas planning efforts stand today. Utility planning processes have been evolving over the past several decades. Dating back to the 1980s, integrated resource planning has addressed bulk system issues, primarily for electric utilities but also in some jurisdictions for significant gas infrastructure. More recent initiatives have focused on electric and gas distribution system planning. These planning requirements have several features in common, and many jurisdictions are continuing to improve them over time. In contrast to siloed electric and gas planning, integration of planning efforts also requires an understanding of how electric and gas utility service territories relate to each other, including ownership structures. We present a few initial examples of utilities and jurisdictions starting down the road of integrated electric and gas planning.

2.1 Integrated Resource Planning

Because of electric cost increases in the 1970s and 1980s, many utility regulators and other policymakers focused their attention on electric utility planning for bulk electric system resources in the 1980s and 1990s. As a result, many jurisdictions across the country implemented significant electric utility regulatory reforms, often referred to as integrated resource planning or least-cost planning.[3] Examples of motivation for these planning reforms include (NARUC 1988):

- Control of system costs
- Reliable and nondiscriminatory provision of critical energy services
- Societal equity, including affordability
- Reasonable administrative costs for utilities, commissions, and other stakeholders
- Least-cost compliance with environmental and public health requirements
- Improved confidence for regulators and stakeholders in utility decision-making (Moskovitz 1989).[4]

These reform efforts had procedural and substantive aspects. Procedurally, these efforts sought to increase transparency in the utility planning processes with public filings, stakeholder input, and commission review. Substantively, these efforts required electric utilities to modify their planning process by improving load forecasting and properly considering energy efficiency policies and other demand-side resources; conducting uncertainty analysis; and implementing competitive bidding for

[3] In 1988, the National Association of Regulatory Utility Commissioners released a two-volume report titled "Least-Cost Utility Planning: A Handbook for Public Utility Commissioners." At p. 7, it notes that a survey conducted by the Arizona Corporation Commission found that 17 states have started some form of least-cost planning and 12 more were either developing a least-cost planning program or considering doing so. (NARUC 1988). A December 1992 report states that a 1991 survey found that 14 jurisdictions had a full integrated resource planning framework and 6 more had an integrated resource planning framework lacking only one element of the full framework. (Hirst 1992).

[4] In this publication, Regulatory Assistance Project founder David Moskovitz argued that ratemaking reforms or other incentives were necessary to achieve the goals of least-cost planning. In July 1989, NARUC passed a "Resolution in Support of Incentives for Electric Utility Least-Cost Planning."

generation resources, among other features.

Figure 1 shows a typical flow chart demonstrating key substantive elements of integrated resource planning. In many cases, this process results in a short-term action plan identifying a range of investments, retirements, procurements, programmatic changes, or other actions needed in 3–5 years.[5]

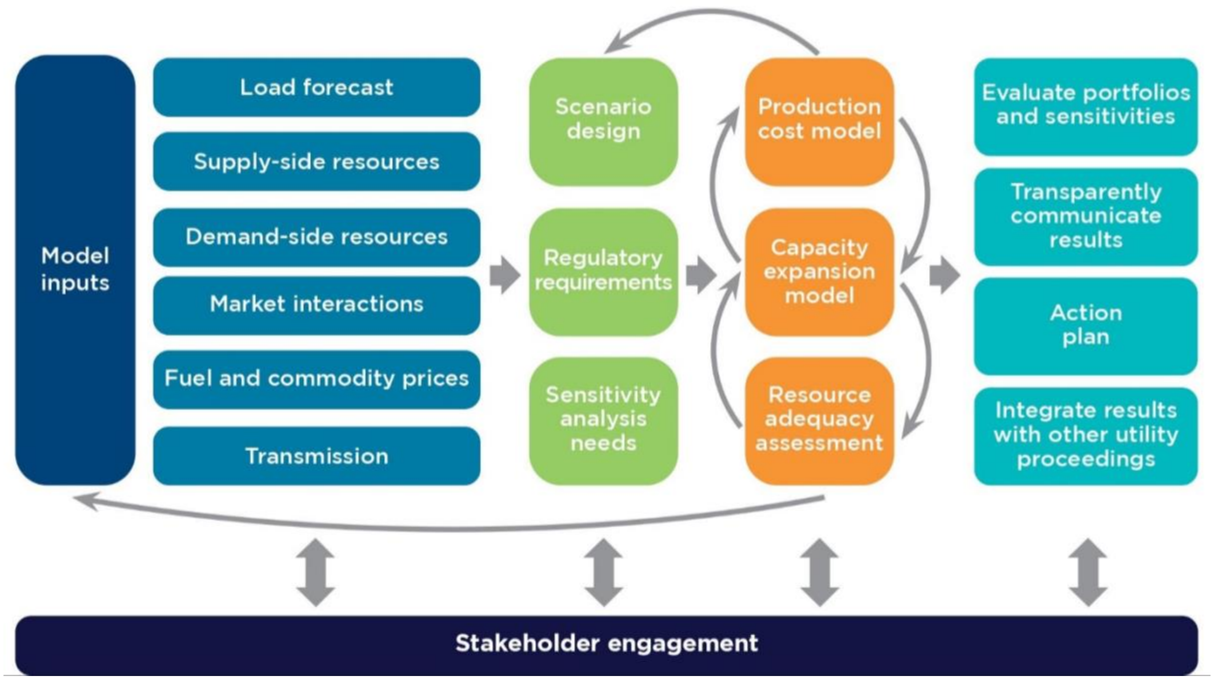

Figure 1. Flow Chart for Electric Integrated Resource Planning

Source: Adapted from Biewald et al. (2024)

Currently, 28 states require electric integrated resource planning, and four others have similar long-term planning requirements for electric generation and/or transmission, although the specifics vary widely (Figure 2 on next page).

Though some utility regulators considered integrated resource planning for gas utilities in the 1990s (Goldman et al. 1993), this was not widely adopted. A few states have long-standing requirements for gas integrated resource planning, including New Mexico (New Mexico PRC n.d.), Oregon (Oregon Administrative Rule n.d.), Vermont (Vermont DPS 2023) and Washington (Washington State Legislature, n.d.). More recently, this has grown to include Minnesota (Minnesota PUC 2024) and Georgia (Georgia PSC 2024). Other jurisdictions have implemented similar long-term planning and approval requirements for gas supply and interstate gas transmission.

[5] One should always be careful to distinguish the decision to make a certain type of investment and the responsibility to execute that investment reasonably well. The utility continues to bear responsibility for the ultimate execution of any approved plan and must take reasonable steps to avoid unnecessary cost overruns or other adverse outcomes.

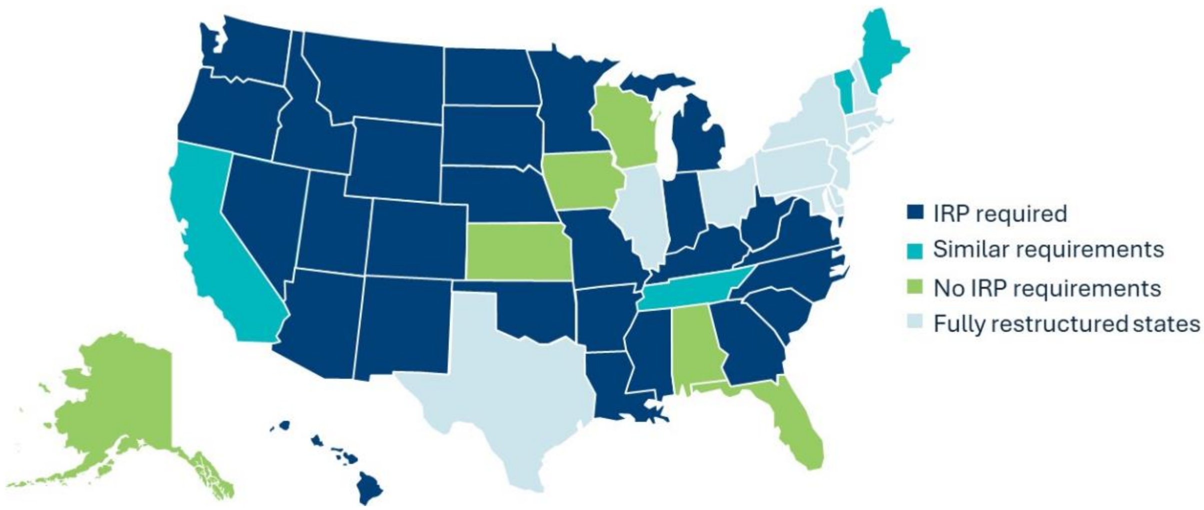

Figure 2. Map of Current Electric Integrated Resource Planning (IRP) Requirements
Source: Adapted from Biewald et al. (2024) with additional Regulatory Assistance Project research

2.2 Modern Electric and Gas Distribution Planning Requirements

Electric and gas distribution system planning, which considers local infrastructure needs, received limited attention from policymakers in the 1990s and 2000s. More traditional review of investments and expenses in rate cases was the principal way state utility regulators exercised their oversight.[6] However, since the late 2000s, electric distribution system planning has been the subject of regulatory interest in many jurisdictions, with multistate collaborations (Mid-Atlantic Distributed Resources Initiative 2019) and national reports (Schwartz et al. 2024) identifying key issues and best practices. More recently, an increasing number of jurisdictions have focused on gas distribution planning (Gridworks 2021, Prause 2022, Strategen 2023b). Increasing levels of capital investment have motivated greater interest in electric and gas distribution planning. Electric distribution system investment has grown from about 27% of total electric capital investment in 2016 to 34% in 2023 for investor-owned electric utilities in the United States (Edison Electric Institute 2024). Gas distribution construction spending exceeded $18 billion each year from 2018 to 2022 (American Gas Association 2023).

As of mid-2024, 22 states and the District of Columbia have electric distribution planning requirements (Figure 3 on next page).[7] At least 13 jurisdictions are considering updated gas distribution planning requirements (Sandoval, Frick, and Deason 2024).[8] As of mid-2024, three state commissions have issued orders on utility filings under updated gas distribution planning rules (New York DPS 2023b, Colorado PUC 2024a, Georgia PSC 2024).

[6] In the past 15 years, another notable trend has been the usage of cost trackers to recover certain kinds of capital investments. For electric utilities, this has included distribution modernization investments. For gas utilities, this has included pipeline replacement investments. Such investments typically have had more streamlined review processes for immediate inclusion in cost trackers.

[7] DC, CA, CO, CT, DE, HI, IL, IN, MA, MD, ME, MI, MN, NM, NV, NY, OR, PA, RI, VA, VT, and WA (Schwartz et al. 2024). In addition, the New Jersey Board of Public Utilities has issued updated grid modernization and interconnection rules: https://www.nj.gov/bpu/newsroom/2024/approved/20240430.html

[8] CA, NY, CO, OR, MA, WA, RI, NV, and IL. (Sandoval, Mims Frick, and Deason 2024). In subsequent research, DC, GA, MD, and NJ have started relevant gas distribution planning docket work.

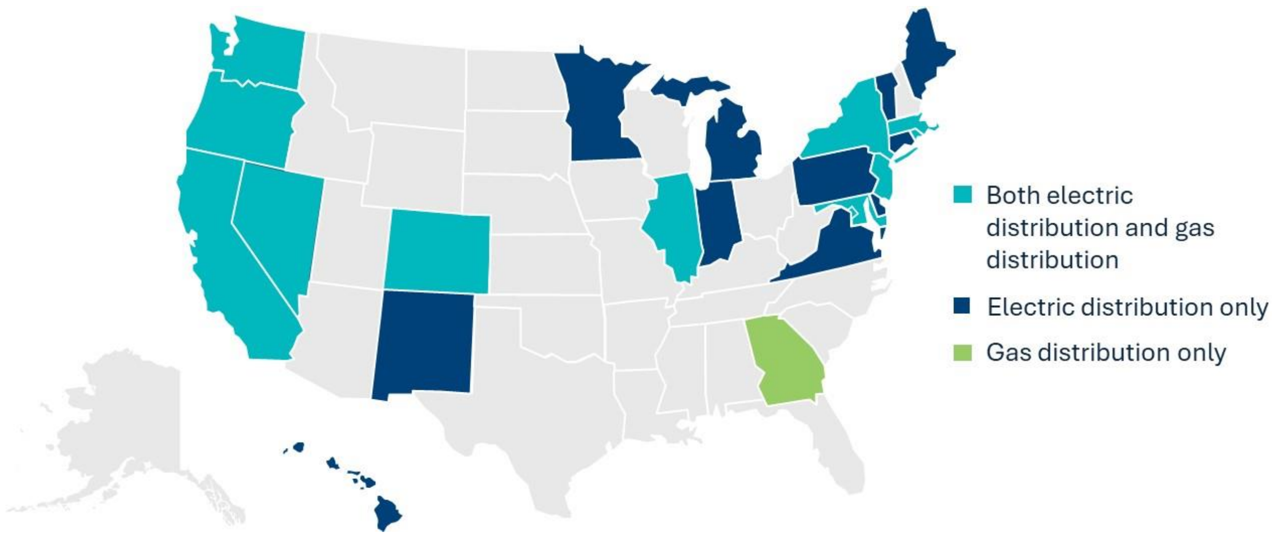

Figure 3. Map of Jurisdictions With Electric and Gas Distribution Planning Requirements
Source: Adapted from Schwartz et al. (2024) and Sandoval, Frick, and Deason. (2024)

Figure 4 shows an electric distribution system planning flow chart. While this flow chart shows some issues that are more unique to distribution-level planning, such as granular locational forecasts, the general structure of distribution planning efforts is similar to the structure of earlier integrated resource planning efforts. Analysts create forecasts based on policy requirements and technology inputs. Given forecasts and the characteristics of the current system, they evaluate alternative investment patterns. Based on these evaluations, a short-term action plan identifies a range of investments, retirements, procurements, programmatic changes, or other actions needed in three to five years.

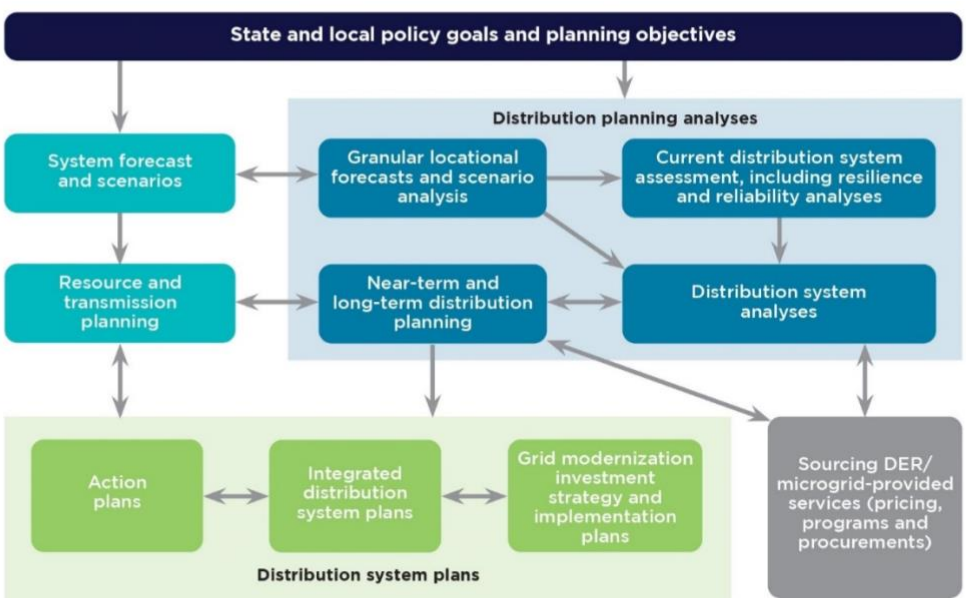

Figure *4*. Flow Chart for Electric Distribution Planning
Source: Adapted from Lawrence Berkeley National Laboratory (n.d.). DER stands for distributed energy resources

2.3 Shared Features of Modern Utility Planning Efforts

Modern utility planning efforts share several features. These include forecasting, system needs assessments, analysis of alternative methods for meeting system needs, and resulting investment and action plans. While not depicted in Figure 4, integrated resource planning and distribution planning requirements often include processes for stakeholder engagement and review by regulators (Schwartz et al. 2024). Understanding these shared features should allow policymakers to consider how those common elements should be linked together in integrated electric and gas planning. Table 1 presents five important shared features across all forms of modern utility planning.

Table 1. Key Shared Features for Modern Utility System Planning[9]

Feature	Description
Advanced forecasting and system modeling	Improved locational detail for load forecasting, customer technology adoption, and up-to-date system modeling using granular data are important to identify system needs correctly.
Disclosure of system needs and value	Well-defined needs and values are necessary to scope alternative solutions.
Improved solution acquisition practices	Traditional utility investments should be compared with programs, competitive procurements and improved customer pricing options.
Support for innovation	New system technologies and customer programs should be fully considered, including testing and scalable pilots.
Meaningful and equitable stakeholder participation	Establishing processes for open dialogue, transparent information sharing, collaboration and consensus-building among stakeholders.

States have implemented related reforms for each of these shared features in the context of integrated resource planning, electric distribution planning, and gas distribution planning. For example, with respect to solutions acquisition practices, the 1988 NARUC *Least-Cost Utility Planning Handbook* (NARUC 1988) observed that "[m]arket-based procedures can be employed, such as allowing different providers of electricity and other energy services to bid against each other for the right to provide that service." In the context of bulk generation resources, many jurisdictions have used different forms of competitive procurements over the decades and have established best practices (Shwisberg et al. 2020). In the context of electric distribution planning, several states have now introduced requirements to consider

[9] List adapted from GridLab 2019, originally in the context of capabilities of electric distribution planning. For a more complete discussion of the relevant capabilities and functionalities of modernized electric distribution system planning, see section 3.4, "Capabilities & Functionality," in U.S. Department of Energy 2020.

non-wires alternatives, namely procurements and programs to cost-effectively defer or avoid utility electric distribution investments when feasible. Building on these examples, a few states have now adopted policies for non-pipeline alternatives to gas distribution investments—procurements and programs to defer or avoid utility gas distribution investments when a superior alternative is identified (Strategen 2023a, Strategen 2023b).

Important details for each of these shared features will vary from jurisdiction to jurisdiction. Even in leading jurisdictions implementing best practices, creating innovative new structures is challenging. (See the callout box on load forecasting.) Of course, current practices will be the baseline on which integrated electric and gas planning must be built. In some cases, it will be necessary to have a particular electric or gas planning capability in place in order to unlock certain integration opportunities. But integration can also provide new ways to upgrade existing electric and gas planning that may not have been possible otherwise.

Evolving Issues in Load Forecasting

While all the components of modernized planning have their purpose, load forecasting bears special discussion in the context of end-use electrification. Load forecasting, combined with modeling of existing system capabilities, indicates whether there is a need for new resources or system investment,[10] particularly when load is projected to grow over time. Detailed alternatives to new utility investments can be properly considered only after utilities and regulators identify the potential need for new utility investment. On the electric side, distributed energy resources may represent an alternative to new utility-scale generation resources or distribution substation capacity expansions. On the gas side, energy efficiency and electrification can be alternatives to system expansions, or segment retirements may serve as an alternative to gas main replacement. However, in all cases, forecasts of load and customer count will significantly influence what mix of investments might be necessary to consider. On the electric side, widespread advanced metering investments have enabled the collection of detailed customer usage data. However, there have been no comparable investments on the gas side, so monthly usage is the most granular customer data available in most cases.

Existing forecasting practices tend to use historic data as their baseline, typically with regression-based extrapolations for several variables going forward. This does not by its nature incorporate new policies and other changing conditions. In particular, estimating the impacts of new policies can be subject to significant uncertainty, which in many cases can mean increased complexity. Historic forecasting practices were also typically focused on large regions, but modern distribution planning must develop more granular locational forecasts to understand the likely timing and size of any needs for local infrastructure upgrades, as well as the potential for decommissioning of segments of the gas system. Electrification has been considered to some extent in utility planning efforts since the early to mid-2010s, but the scale and location of adoption continues to be difficult to predict. See, e.g., Grid Modernization Advisory Council (2023) p. 10 for discussion of the impacts of electrification in the context of electric distribution planning and Colorado PUC (2024a) pp. 8–23 for discussion of the impacts of electrification in the context of gas distribution planning.

[10] Retirement and decommissioning of certain assets can also be justified if load is declining or if investments in other alternatives are more cost-effective than replacing, maintaining, or reconditioning existing assets.

2.4 Service Territories and Ownership Structures

Utility ownership structures and service territories will also have an important influence on integration of electric and gas planning. In many places, utility service territories reflect regulatory and business considerations from the early 20th century and were not designed for administrative convenience. Since then, mergers and sales have shaped today's electric and gas service territories. Figure 5 shows three illustrative service territory arrangements.

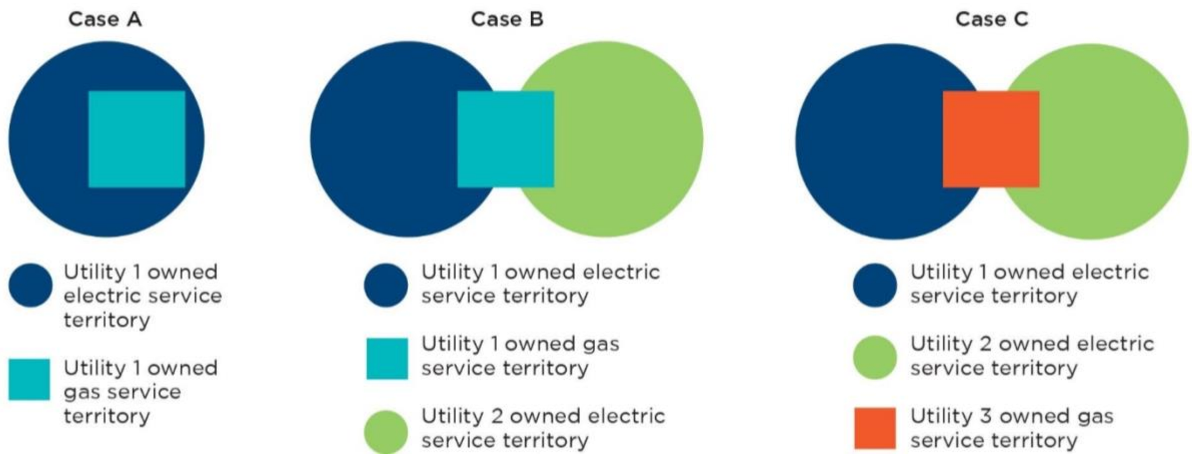

Figure 5. Illustrative Electric and Gas Service Territory Layouts

As shown in Case A, a utility company may own both an electric utility and a gas utility that serves a given area. This setup is often referred to as a "dual-fuel utility." This can take two different forms. In some cases, the jointly owned electric and gas assets may be owned and operated together by a single corporate entity, and customers may even receive one bill for both gas and electricity from that one company. In other cases, two separate corporate affiliates may be owned by one parent company but operated independently.

In Case B, a gas utility service territory overlaps partially with an affiliated electric utility but also shares a different part of the gas service territory with another electric utility. In Case C, two separate electric utilities share parts of their service territories with a gas utility, and none of the entities have common ownership.

Moreover, some investor-owned utility territories overlap with publicly owned utility territories. For example, a city may have a municipal electric utility while receiving service from an investor-owned gas utility. Publicly owned utilities have different governance structures and are often not under the jurisdiction of the state utility commission. In areas where investor-owned utility service territories overlap with publicly owned utilities and cooperatives, public utility commissions may not be able to direct the integration of electric and gas planning.

In states with energy efficiency utilities, in particular those with electrification goals, there may be an additional layer of complexity when integrating electric and gas planning. For example, in Maine, electric utilities are required to "incorporate relevant elements of the Efficiency Maine Trust triennial plan…including plans to implement energy efficiency programs... beneficial electrification programs such as heat pump" initiatives (Maine Revised Statutes 35-A § 3146).

In addition, other utility-provided energy services, such as district heating and cooling, have important interactions with the electric and gas systems and may provide alternative ways to serve customer end-use needs. Such alternatives span longstanding technology options, such as steam, but networked geothermal systems, also called thermal energy networks, are relatively new. (See callout box.)

Thermal Energy Networks: A New Utility-Scale Option for Heating and Cooling

Thermal energy networks, also called networked geothermal or community geo, share much in common technologically with ground-source heat pumps that serve a single building (Geothermal Technologies Office 2023). A liquid in a pipe that is circulated under the ground is used as an energy reservoir and, given the relatively constant temperature of the earth, can be used to transfer energy into or out of a building via a heat pump unit. The heat pump unit inside the building does use electricity, but typically much less than an air-source heat pump or more traditional electric heating and cooling appliances. The innovation of thermal energy networks is that they are shared and can be scaled up to serve a whole neighborhood or perhaps a larger geographic area. Compared to a single-customer ground source heat pump, this may bring economies of scale and benefits due to diversity of demand but may also bring additional organizational and economic complications as well. Where thermal energy networks replace combustion heating technologies, they can be categorized as electrification. This technology has been used on university campuses (Colorado Mesa University 2024) and in other applications for many years but is now being piloted as a network for residential and commercial customers in Massachusetts (Eversource n.d.)[11]. Additional states are not far behind, notably New York (New York DPS 2023a).

2.5 Integrated Electric and Gas Planning to Date

Traditionally, electric and gas planning have proceeded separately, largely siloed from each other. As observed by Eversource in its Massachusetts electric system modernization plan filing, "[g]as and electric utilities plan and operate their networks in parallel to one another even when they are affiliated companies with a common parent company because historically there has been little need for coordination" (Eversource 2024a, p. 641).

Integrated electric and gas planning efforts have largely been limited to a few dual-fuel utilities where relevant electric and gas service territories have significant overlap, such as Pacific Gas & Electric in

[11] A novel aspect of Eversource's networked geothermal energy demonstration project is that the Department of Public Utilities permitted the utility to recover project costs even though it is not a natural gas project. This is a significant shift from traditional cost-recovery, and is an additional component that states may consider when integrating electric and gas planning (Massachusetts DPU, 2024).

California (California PUC 2023); Xcel Energy in Colorado (Colorado PUC 2024b); and both ConEdison (ConEdison 2022) and Central Hudson Gas & Electric in New York (Central Hudson 2024). Even these three examples are only initial steps down the path of integration. For example, a Colorado Public Utilities Commission order found that Xcel Energy's electric and gas system modeling was not sufficient to support key claims about investment outcomes— see the excerpt in the callout box. In addition, Massachusetts and Washington have emerging requirements for cross-fuel collaboration. In Massachusetts, utilities must consider integrated planning (Massachusetts DPU 2023, pp. 87, 110), and Washington required Puget Sound Energy, a dual-fuel utility, to use integrated electric and gas system planning, although this statute has been amended by a subsequent ballot initiative (Washington State Legislature 2024).

"We recognize that modeling and optimizing investment in both gas and electric systems during this period of transition spurred on by the clean heat plan is an extensive exercise. Nonetheless, we find that [Xcel Colorado or the Company]'s application did not adequately support key transmission and distribution investment outcomes it suggests will be required in high-electrification scenarios. Accordingly, we expect the Company to develop tools that are appropriately capable of forecasting the complex relationship between [beneficial electrification] adoption, electric infrastructure investment and gas infrastructure investment, and to provide a thorough presentation of such modeling capabilities in the Company's next clean heat plan application, if not sooner. The Company should endeavor to provide consistent information on the assumptions across Commission proceedings to avoid significantly different values from being provided for the same input across separate proceedings."

—Colorado PUC Clean Heat Plan Order (Colorado PUC 2024b)

3. Benefits and Challenges of Integrated Electric and Gas Planning

As with earlier stages of planning reforms, efforts to integrate electric and gas planning should be linked to benefits in terms of improved outcomes. Unlocking these benefits requires addressing the challenges that arise within each silo of electric and gas planning.

3.1 Benefits of Integrated Electric and Gas Planning

Integrating electric and gas planning can create several benefits, including:

Lower energy system costs and improved affordability: Improved data sharing, forecasting, collaboration, and jointly optimized solutions can produce more robust and cost-effective investments and better designed customer programs, ultimately leading to a lower-cost electric and gas system and improved customer affordability.

Improved reliability and resilience for customers: More accurate data and better-informed investments and procurements should better enable reliability for end-use customers and allow for systems to recover more quickly from disruptive events.

Greater confidence in investment choices: More transparent and consistent planning frameworks can improve certainty for regulators and help achieve agreement, potentially more quickly, between utilities and other parties in subsequent proceedings.

More equitable allocation of costs across fuels and customers: Analysis and data created during the process of integrated planning can be used to improve the allocation of costs between electric and gas customers, across customer classes, and within classes to achieve equitable outcomes.

Streamlined administrative processes and reduced burden on regulators and stakeholders: Centralized processes with full and fair participation from all stakeholders, government entities, and utilities can eliminate duplicative litigation across proceedings and reduce regulatory review time. (See the callout box on consolidating planning.)

Least-cost compliance with environmental and public health requirements: Better coordination across electric and gas systems can identify the lowest-cost strategy for building sector decarbonization, including electrification, by optimizing compliance paths across systems.

Consolidating Planning Filings for Dual-Fuel Utilities: Example in Washington State

Puget Sound Energy, a major electric and gas utility in Washington state, has been required by statute to file an integrated system plan in the coming years (Washington State Legislature 2024). The statute provides that the utility will no longer need to file separate electric or gas plans, and previous planning requirements should be consolidated. The statute provides for the conclusion of a rulemaking process by the Washington Utilities and Transportation Commission by July 1, 2025 and for the filing of the first integrated system plan by January 1, 2027. The statute itself contains little direction about how to integrate planning across fuel types but does contain a range of more detailed requirements, which have been subsequently amended by a state ballot initiative.

3.2 Challenges to Achieving Integrated Electric and Gas Planning

Understanding the challenges of status quo electric and gas planning processes is crucial to defining a path forward and unlocking the benefits described above. In general, electric and gas utilities do not have financial incentives to coordinate their planning processes. As a result, current processes pose a number of challenges that utilities and regulators must overcome to achieve well-integrated planning. These challenges can be described across four dimensions, discussed below.

Siloed Organizations and Lack of Visibility

Siloed electric and gas planning exercises cannot see critical customer and system information that will be relevant to key decisions. For example, a gas utility‘s lack of visibility into electric system headroom makes it difficult to judge whether electrification is a viable alternative to gas system investments. The extent of the issue will likely depend on the overlap of electric and gas service territories and the relevant ownership structures.

Even in the best-case scenario of jointly owned electric and gas utilities with overlapping service territories, there will be significant issues to work through. Large organizations, such as electric and gas utilities and public utility commissions, often struggle to efficiently share information and collaborate across business segments (Edmondson, Jang, and Casciaro 2019). Changes may require direction from leadership and could result in additional staff and resource needs. In some cases, electric and gas utilities owned by the same parent company in a given jurisdiction operate entirely separately, without shared data systems, shared office locations, or existing collaboration. Deliberate reorganization of personnel may be needed to foster integrated electric and gas planning, and decision makers will need to consider the terms of cooperation between the electric and gas sides of the company, including the secure transfer of data.

When faced with separately owned electric and gas utilities that share service territories, commissions will likely need to define the terms of cooperation between utilities to ensure communication and reasonable procedures for joint planning work. In particular, the secure transfer of data, particularly any sensitive customer and system data, will be needed to protect customer privacy and ensure the protection of each utility system.[12] This will be further discussed in Section 5.1.

Insufficient Collaboration and Stakeholder Input

Robust utility decision-making requires substantive input from a wide range of perspectives. Furthermore, any entity that does not have a fair chance of participating in a planning process may bring legitimate concerns forward later on in a rate case or other proceeding. As a result, it is in the interest of both utilities and regulators to provide effective mechanisms for stakeholders and relevant government agencies to learn about the relevant issues, provide their perspectives, and collaborate on effective solutions. Many of these organizations may participate in electric and gas planning separately but may have fuel-specific staffing and experts that need to be brought together in a thoughtful manner. In addition, providing sensitive data to stakeholders, particularly private businesses and nongovernmental organizations, raises additional issues regarding customer and system data that needs to be protected. Appropriate controls such as nondisclosure agreements can help, but certain information may only be appropriate to share with government entities or other utilities with sophisticated information protection capabilities.

Suboptimal Inputs and Inconsistent Forecasts

Typically, assumptions and inputs used to inform forecasts are not coordinated across gas and electric utility planning. Inconsistent forecasts and assumptions across utility planning are likely to occur for a variety of reasons, such as use of different forecasting techniques and different levels of effort and expense put into incorporating public policies. Plans based on different forecasts can result in inconsistent and inefficient investment decisions, which may be reflected in subsequent procurements and program structures. (See the callout box on procedural aspects of inconsistent forecasts.)

Procedural Aspects of Inconsistent Forecasts

Uncoordinated utilities may predict significantly different solutions to address key challenges. For example, with respect to decarbonization goals, an electric utility may incorporate aggressive building electrification assumptions into its forecasts and a gas utility may use mild building electrification assumptions, paired with substantial amounts of renewable natural gas and clean hydrogen. Conflicting viewpoints could be addressed separately and adjudicated within each silo by a utility commission, but it is likely more accurate, fair, and administratively efficient to address these issues in a shared forum where all interested parties can provide their perspective.

[12] In addition to state statutes and regulations, the need to protect critical energy infrastructure information as defined by the Federal Energy Regulatory Commission is sometimes raised at the state level: https://www.ferc.gov/ceii. Significant work on cybersecurity has also been done by NARUC: https://www.naruc.org/core-sectors/critical-infrastructure-and-cybersecurity/cybersecurity-for-utility-regulators/cybersecurity-manual/. In some cases, there are also direct cybersecurity requirements issued by the Department of Homeland Security (e.g., for significant interstate pipelines): https://www.dhs.gov/news/2021/07/20/dhs-announces-new-cybersecurity-requirements-critical-pipeline-owners-and-operators.

Incomplete Analysis of Interactive Electric and Gas Investment Impacts

Under the status quo, the analytical framework for planning looks at only one utility system at a time. Electric system costs are not estimated as a determinant of gas system costs and vice versa. As a result, planning processes are not coordinated to estimate joint costs or to find joint solutions. Making investments and program decisions without a holistic view risks uncoordinated solutions and limits the options available for providing cost-effective and reliable energy services.

4. Characteristics and Indicators of Integrated Electric and Gas Planning

Based on a review of current planning practices, literature to date, and selected interviews with state regulatory staff, we have identified four characteristics of integrated electric and gas planning:

(1) Improved Organization, Communications, and Collaboration
(2) Aligned Inputs for Forecasting and Modeling
(3) Reformed Analytical Structure
(4) Sufficient Outputs for Procurements, Programs, and Other Processes.

This chapter describes each **characteristic** and presents two to three **indicators** for each that can be used to track progress toward achieving the characteristics. These characteristics correspond to different stages of the planning process.[13] Significant progress in modernizing electric and gas planning is an important foundation for integration, so these characteristics and indicators build upon the key planning capabilities described in Section 2.

In Table 2 through Table 5, for each characteristic, we estimate the link between each indicator and the six categories of integrated electric and gas planning benefits discussed in Section 3. While a broad package of policies will likely be necessary for effective integration, states can consider the principal benefits for each indicator when designing and implementing potential reforms. In each table, we rate the likely impact of each indicator on each benefit category. We developed each rating based on our understanding of past planning reforms and the nature of the indicator. For example, in Table 2, "Mechanisms for education, collaboration, and stakeholder input" has the highest impact with respect to increased confidence in utility decision-making among the indicators in Section 4.1. This indicator is crucial to ensure that all government entities and stakeholders understand the challenges facing utilities and engage to create solutions.

Section 5 will discuss specific steps regulators can take to move toward achieving the indicators presented here.

4.1 Improved Organization, Communications, and Collaboration

<u>Characteristic</u>: Gas and electric planners communicate efficiently and collaborate well with each other and with government entities and stakeholders. Planners, policymakers, and solutions providers receive the correct data in a timely and reasonable manner to make prudent decisions.

<u>Indicators (Table 2):</u>

- *Integration across internal organizational silos*: Dual-fuel utilities, commissions, and other stakeholders reorganize personnel and corporate structures to have cross-fuel deliberations.

[13] The characteristics and indicators are not chronological implementation steps but define the end state for an integrated electric and gas planning process. Further discussion on steps toward this end state is presented in Section 6.

- *Effective data sharing*: Separately operated gas and electric utilities with overlapping service territories establish methods to securely exchange data with their counterparts and answer specific inquiries. Utilities and regulators establish mechanisms for additional data sharing with government entities, stakeholders, and solutions providers as appropriate.
- *Mechanisms for education, collaboration, and stakeholder input*: Policymakers and utilities provide robust forums and stakeholder support specific to integration issues.

Principal Benefits (Table 2):

- Lowering costs
- Ensuring reliability
- Improving stakeholder and regulator confidence in investment decisions
- Streamlining processes and reducing duplicative litigation of key issues across multiple proceedings
- Cost-effective compliance with environmental and public health requirements.

Table 2. Improved Organization, Communications, and Collaboration: Indicators and Benefits

Indicator	Benefit					
	Lower costs	Reliability	Greater confidence	Equitable cost allocation	Streamlined processes	Least-cost compliance with environment and health
Integration across internal organizational silos	Moderate	Moderate	Full	Low	High	Moderate
Effective data sharing	High	High	High	Moderate	High	Moderate
Mechanisms for education, collaboration and stakeholder input	Moderate	Moderate	Full	Low	High	High

○ = None ◔ = Low ◑ = Moderate ◕ = High ● = Full

4.2 Aligned Inputs for Forecasting and Modeling

Characteristic: Forecasters and planners use aligned inputs and create consistent forecasts and scenarios properly reflecting public policies.

Indicators (Table 3):

- *Consistent and aligned forecasts and inputs across proceedings*: Regulators or utilities create a centralized process for forecasting to allow separate planning proceedings to reach consistent and coordinated results.
- *Best available data inputs and up-to-date modeling techniques*: Regulators establish best practices for data and modeling, as well as assumptions and estimates for jurisdiction-wide issues, to provide for efficient results and eliminate duplicative analysis.

Principal Benefits (Table 3):

- Lowering costs
- Ensuring reliability
- Improving the confidence of regulators and stakeholders in investment decisions
- Streamlining processes and reducing duplicative litigation of key issues across multiple proceedings
- Cost-effective compliance with environmental and public health requirements.

Table 3. Aligned Inputs for Forecasting and Modeling: Indicators and Benefits

Indicator	Benefit: Lower costs	Reliability	Greater confidence	Equitable cost allocation	Streamlined processes	Least-cost compliance with environment and health
Consistent and aligned forecasts and inputs across proceedings	Full	Full	Full	Low	High	High
Best available data inputs and up-to-date modeling techniques	Full	Full	Full	Low	High	High

○ = None ◔ = Low ◑ = Moderate ◕ = High ● = Full

4.3 Reformed Analytical Structure

Characteristic: Utilities and commissions evaluate electric and gas system costs and impacts comprehensively in planning proceedings that impact both fuels and properly consider solutions across systems and nonutility resources.

Indicators (Table 4):

- *Improved sequencing and coordination of utility filings*: Regulators adjust the ordering and cadence of proceedings to build upon each other and leverage cost estimates across proceedings, with the potential for joint filings.
- *Joint assessment of electric and gas system impacts and costs*: Utilities have sufficient information and analytical tools to optimize joint system costs, which requires understanding of impacts for varying investment and program options across fuels.

Principal Benefits (Table 4):

- Lowering costs
- Ensuring reliability
- Improving confidence of regulators and stakeholders
- Streamlining processes and reducing duplicative litigation of key issues across multiple proceedings
- Cost-effective compliance with environmental and public health requirements.

Table 4. Reformed Analytical Structure: Indicators and Benefits

Indicator	Benefit					
	Lower costs	Reliability	Greater confidence	Equitable cost allocation	Streamlined processes	Least-cost compliance with environment and health
Improved sequencing and coordination of utility filings	Moderate	Moderate	Moderate	Moderate	Full	Moderate
Joint assessment of electric and gas system impacts and costs	Full	Full	Full	Moderate	Low	High

○ = None ◔ = Low ◑ = Moderate ◕ = High ● = Full

4.4 Sufficient Outputs for Procurements, Programs, and Other Processes

Characteristic: Joint planning processes create clear and sufficient information to implement subsequent decisions fairly and efficiently. Utilities, commissions, and state agencies leverage these outputs to improve customer programs and other processes, such as cost allocation and affordability programs.

Indicators (Table 5):

- *Use planning data to structure multi-fuel procurements and improve customer programs*: New outputs of both electric and gas data are provided to efficiently and fairly run multi-fuel procurements and better target other programmatic efforts.
- *Use planning analysis to improve cost allocation*: Data and analysis from integrated planning processes, particularly benefits calculations, are used to estimate equitable cost recovery methods across fuels and customers.
- *Use combined customer data to improve affordability programs*: Utilities can create a joint database that combines electric and gas billing data for individual customers served by more than one utility. Affordability programs and energy burden analyses can then utilize combined customer electric and gas billing data instead of averages and estimates.

Principal Benefits (Table 5):

- Lowering costs
- Ensuring reliability
- Improving confidence of regulators and stakeholders
- Equitable cost allocation
- Streamlining processes and reducing duplicative litigation of key issues across multiple proceedings
- Cost-effective compliance with environmental and public health requirements.

Table 5. Sufficient Outputs for Procurements, Programs, and Other Processes: Indicators and Benefits

Indicator	Benefit					
	Lower costs	Reliability	Greater confidence	Equitable cost allocation	Streamlined processes	Least-cost compliance with environment and health
Planning data used to structure multifuel procurements and improve customer programs	High	High	High	Low	Low	High
Planning data and analysis used to improve cost allocation	None	None	Low	Full	High	High
Combined customer data used to improve affordability programs	None	None	Low	Full	Full	Low

= None = Low = Moderate = High = Full

5. Implementation Options for Integrated Electric and Gas Planning

This chapter presents specific implementation steps that a jurisdiction can take for each characteristic and indicator of integrated electric and gas planning. For some indicators and specific actions, there are multiple options that a jurisdiction can explore. Regardless of where a jurisdiction is starting from, integrated electric and gas planning will need to be coordinated with advancements within each electric and gas planning silo as well.

5.1 Improved Organization, Communications, and Collaboration

Internal Organizational Reforms

- *Create cross-functional teams in dual-fuel utilities*. Utilities that provide both electric and gas service can promote robust information sharing within the utility by establishing cross-functional teams.[14] For example, Xcel Energy, which operates electric and gas utilities across several states, announced a new Integrated Systems Planning department across electric and gas operations (Penrod 2023).
- *Create cross-fuel teams at public utility commissions*. Similar to cross-functional teams at dual-fuel utilities, public utility commissions can establish teams to ensure that review of filings that impact both electric and gas systems are properly vetted.

Communications and Data Sharing

- *Create specific communications channels to ensure necessary collaboration across utilities that have overlapping service territories or dual-fuel utilities with internal organizational separation*. Individual team members at both organizations could be identified with appropriate sharing of individual contact information, but utilities can also consider adopting more structural solutions, such as periodic inter-utility meetings.
- *Establish a clear approach to transfer and access data*. Transfer of, and access to, data can also be normalized across utilities, government entities, and any other appropriate stakeholders. Some data can be shared publicly,[15] some may be appropriate to share only with the protection of a nondisclosure agreement, and some may be appropriate to share only with other utilities

[14] While not specific to electric and gas planning, NV Energy created a new business unit, Integrated Energy Services, that brings together "the demand-side customer programs, renewable energy, battery storage and electric vehicles with the integrated grid planning function. This group facilitates a holistic customer experience across NV Energy programs ensuring the maximizing of DER grid integration and benefits. Additionally, new programs and system investments facilitate utility ownership of DERs including EV infrastructure, community-based solar PV resources and distributed storage for operational needs." NV Energy (2023) p26.

[15] As a baseline, any information, data, or investment plans shared publicly can be reasonably assumed to be accessed by other utilities and stakeholders, although care must be taken to ensure that information is provided in a convenient and useable format. For example, an electric distribution company may publish circuit-by-circuit historic peak load along with future load projections. See https://experience.arcgis.com/experience/3e0b3d6477c34e74b56285160dac8810. Of course, not all customer, system, and planning data are appropriate for public disclosure, given the need to protect customer privacy, confidential business information, and system security.

and government entities with a substantial interest, with measures in place to protect sensitive information. While elements of data-sharing may be established separately in each silo for electric and gas planning, new measures may be helpful specifically for integrated gas and electric planning. Integrated system mapping tools can be useful for cross-utility collaboration, as well as engagement with key stakeholders such as municipalities (Rocky Mountain Institute and National Grid 2024). General best practices for format and procedures across silos would be useful as well, including harmonizing software to facilitate data sharing.

Collaboration and Stakeholder Support

- *Establish an electric-gas collaborative*. If permitted by state law, various entities (e.g., public utilities commissions, consumer advocates, environmental and equity justice representatives, utilities) can form teams to collaborate and share information. A collaborative can promote robust discussion, improve the quality of information in regulatory proceedings, develop solutions with broad support, build trust among parties, and produce better plans. For example, Massachusetts created the Office of Energy Transformation with an associated stakeholder task force, including electric and gas utilities, to shepherd several aspects of the overall energy transition (Massachusetts EEA 2024). In addition, the Massachusetts Department of Public Utilities has ordered gas distribution companies and electric distribution companies to consult with stakeholders on potential joint planning processes (Massachusetts DPU 2023, pp. 131–32). In Washington State, Puget Sound Energy is preparing to execute its newly required Integrated System Plan, which covers both its electric and gas systems, with its existing stakeholder collaborative, the Resource Planning Advisory Group (Puget Sound Energy 2024). Depending on a jurisdiction's rules, this could also take place within the context of a commission docket on these topics.
- *Provide financial support for stakeholders*. Participating in regulatory proceedings can often be expensive and time-consuming for stakeholders. Several states help mitigate this burden by offering intervenor compensation (NARUC 2021). The details of these programs, including the types of organizations that qualify and overall funding budgets, vary from jurisdiction to jurisdiction.
- *Enhance educational and technical support for stakeholders*. There are a variety of formal and informal ways to provide education on the details of regulatory practices and technical issues for interested stakeholders. This includes workshop presentations with an opportunity for questions, but there are many more possibilities. Stakeholders can be given access to utility modeling tools to understand their capabilities and propose alternatives. The New York Department of Public Service established a related practice by requiring utilities to fund an independent third-party consultant working for commission staff to aid in the review of long-term gas plans (New York DPS 2022). Although this is intended as an adjunct to commission staff expertise and resources, it also serves the interests of stakeholders throughout the overall process in providing transparent review of technical issues.

5.2 Aligned Inputs for Forecasting and Modeling

New Processes to Coordinate Forecasting

- *Institute a new electric and gas forecasting proceeding*. Regulators can require the electric and gas utilities to participate in a combined electric and gas proceeding and allow stakeholders to participate as well. The British Columbia Utility Commission (BCUC) in Canada took this approach.[16] In December 2021, BCUC instituted a proceeding entitled “Energy Scenarios” for its principal electric utility, BC Hydro, and principal gas utility, FortisBC Energy (BCUC 2022). To date, this proceeding has consisted of two rounds of requests from BCUC and responsive filings from the electric and gas utilities regarding load forecasts and underlying inputs. BCUC has continued to encourage collaboration between BC Hydro, FortisBC Energy, and other utilities on the topics of input assumptions and forecasting (BCUC 2024).
- *Develop a joint forecasting approach*. States or utilities can lead the development of a joint electric and gas forecasting approach that includes input from stakeholders. Utilities can then use these joint forecasts, or components of them, for planning purposes. Gas utilities in California currently produce a report required by the California Public Utilities Commission every two years (California Gas and Electric Utilities 2022). The *New England Avoided Energy Supply Components* study, sponsored primarily by New England electric and gas utilities, is another precedent for this approach (Synapse Energy Economics 2024). The study sponsors, government agencies, and stakeholders oversee the design of the analysis and final report.
- *Create a centralized state agency forecasting process*. States can establish their own forecasting process that can be used to inform utility forecasts, or as a direct input into utility planning.[17] The California Energy Commission develops a state forecast for the Integrated Energy Policy Report every two years (California Energy Commission n.d.). The most rigorous elements of the report to date focus on electric issues, but it could be used as a starting point for states interested in integrating electric and gas forecasts. The Indiana Utility Regulatory Commission has designated a team of academics within the state to provide forecasting assistance (Purdue University n.d.).

Improved Inputs and Modeling Approaches

- *Incorporate the best data sources and technology inputs*. Additional data should be shared across utilities including relevant customer information, technology assumptions, costs, and performance that inform customer adoption. This data should be up-to-date and consistent across planning efforts. (See callout box on using gas customer data to improve locational electric forecasts.)
- *Perform comprehensive jurisdictional-level analyses of federal, state, and local policies*. Modeling done for broader state energy and decarbonization strategy purposes can inform more specific forecasts needed for planning purposes. Massachusetts, Washington, and New

[16] Example first cited in this context in Strategen (2023b), pp. 54–55.
[17] Independent system operator and regional transmission operator forecasts are not subject to state jurisdiction, but collaboration between states and independent system operators could be useful to minimize discrepancies between state-level proceedings and such forecasts.

Jersey developed state energy strategies that chart the least-cost energy path to achieve their decarbonization goals. Electric and gas forecasts informed the modeling (NASEO 2022, Massachusetts EEA 2020).

- *Construct consistent scenarios and other forms of uncertainty analysis*. Scenario planning and uncertainty analysis are important methods for understanding the risks and contingencies for different investment pathways. These methods should be coordinated across utility planning efforts and consistent with broader jurisdiction level analyses to ensure scenarios typically developed across silos are analytically complementary.

Cross-Cutting Benefits from Integration: Using Gas Customer Data to Improve Locational Electric Forecasts

Academic analyses have examined the distribution costs associated with transportation and heating electrification in Pacific Gas & Electric service territory in California using detailed customer data obtained from the utility (Elmallah, Brockway, and Callaway 2022). Using these data, the authors were specifically able to isolate the impacts of heating electrification on distribution feeder capacity. They estimated that through 2050, "electrification of residential space and water heating will lead to fewer impacts on distribution feeder capacity than [electric vehicle] charging, but that both transitions will require an acceleration of the current pace of upgrades." Using more detailed gas customer data to create better electric forecasts should allow utilities to create more accurate investment plans. It can also enhance the ability to procure cost-effective alternatives to electric utility investment, frequently referred to as non-wires alternatives, or a combination package of utility investment and non-wires resources. These types of enhancements in forecasting should safeguard locational reliability by helping to manage unexpected load growth. Managing unexpected load growth in turn should allow for more predictable investment planning and a longer timeline to consider the procurement of alternatives. Collectively, this should allow for improvements in the cost-effectiveness of electric system investment and least-cost decarbonization. Better forecasting should also increase the confidence of regulators and stakeholders in utility investment patterns and provide more security for utility investors.

5.3 Reformed Analytical Structure

Improved Sequencing and Coordination of Utility Filings

- *Align filing timing for single-fuel utilities with overlapping service territories*. For example, the planned filing timelines for a gas utility serving a particular area could come six months after the filing for the electric utility covering the same area, so the second utility filing can build from the information in the previous filing.
- *Require collaboration or joint filings between utilities with overlapping service territories*. For example, in its December 2023 order, the Massachusetts Department of Public Utilities ordered each gas distribution company to coordinate with electric distribution companies on certain pilot projects (Massachusetts DPU 2023, p. 87). More broadly, utility commissions could require more partnership on aspects of utility's planning efforts, which could lead to joint filings. Depending upon the scope of any joint filings, this could either be in addition to typical single-

utility planning filings or a partial or complete substitute for those filings.

Joint Assessment of Electric and Gas System Impacts and Costs

- *Simultaneously analyze the impacts and costs of alternative investment and program strategies on the electric and gas system*. This joint analysis distinguishes integrated electric and gas planning from siloed planning processes. Figure 6 illustrates an analytical process for integrated planning conceptually, including consideration of non-wires and non-pipeline alternatives. Conceptually, this is straightforward for dual-fuel utilities, particularly those represented by Case A in Figure 5. For other situations, where separate electric and gas utilities serve the same area, the different characteristics of integrated planning must come together to enable a comprehensive filing: cross-organization collaboration and data sharing (Section 5.1), coordinated forecasting efforts (Section 5.2), and the use of accurate and well-designed utility outputs (Section 5.4).

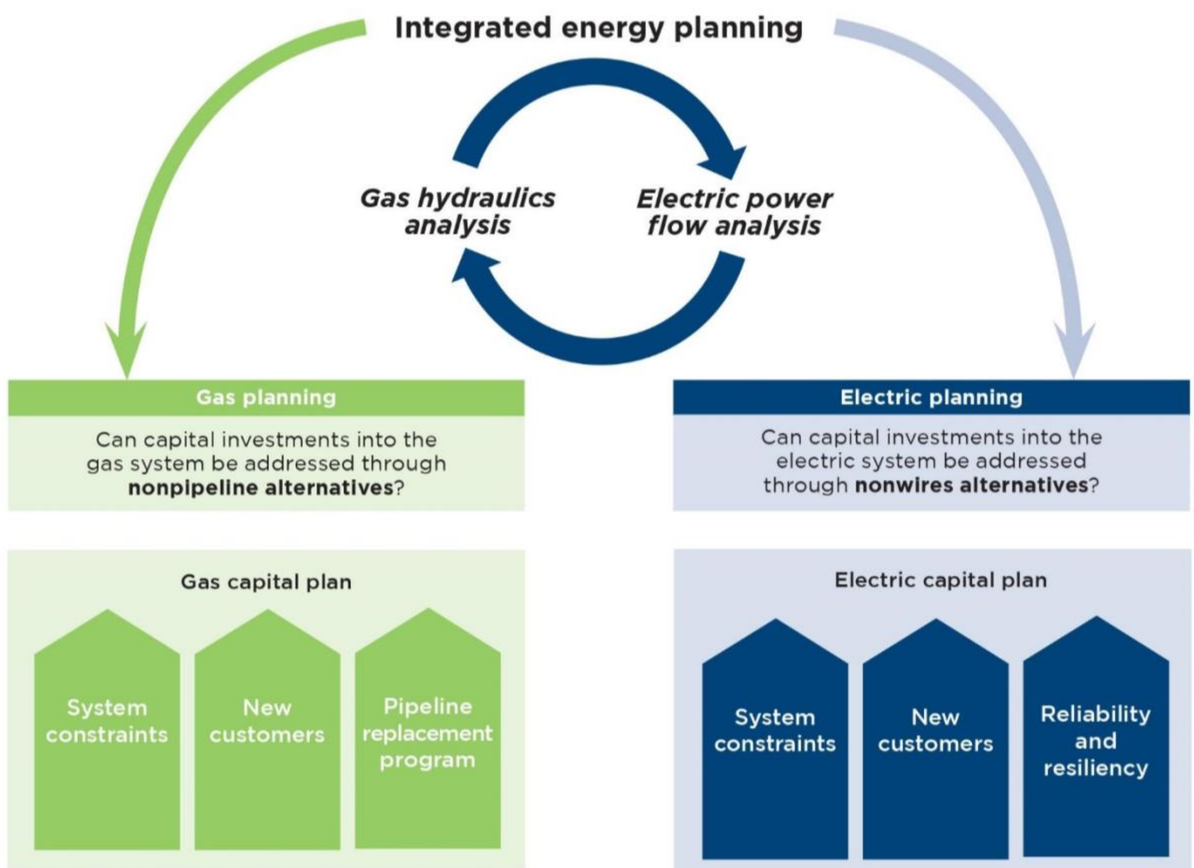

Figure 6. Iterative Analysis of Electric and Gas System Impacts

Source: Adapted from Eversource (2024b)

5.4 Sufficient Outputs for Procurements, Programs, and Other Processes

Use Planning Analysis to Structure Multi-fuel Procurements and Programs

- *Enable multisystem procurements*. In an integrated electric and gas planning process, projects or procurements may impact both the electric and gas systems in the same area. Regulators can use an integrated planning process to design solicitations that properly include both electric and gas utility participation if more than one utility serves the relevant area. This could lead, for example, to simultaneous procurement of a non-pipeline alternative and a non-wires alternative, or investment in thermal energy networks. The chosen solution will often consist of both utility investments and alternatives. A coordinated procurement process will require structured data from both utilities to inform bidders as well as cooperation between the utilities to evaluate options for meeting the needs of all customers and systems cost-effectively and reliably. Utilities can also coordinate the timing of individual utility filings and any joint filings to best support a joint procurement process. Utilities have worked together to undertake complex solicitations collectively in other contexts. For example, in Massachusetts, the electric utilities, in conjunction with the Department of Energy Resources, have overseen solicitations for long-term contracts for offshore wind and other clean energy resources (Massachusetts Clean Energy n.d.).
- *Use planning outputs to inform programmatic choices*. Similarly, program offerings from electric and gas utilities, as well as relevant entities such as energy efficiency utilities or other solutions providers, can benefit from improved outputs from the planning process. (See callout box on the evolution of customer facing programs to incentive electrification.) This applies to locational improvements to energy efficiency and demand response programs but also extends to newer technology options. For example, investment in thermal energy networks can reasonably be informed by data on the constraints and issues on both electric and gas systems. Compared to electrification through air-source heat pumps, thermal energy networks require additional shared infrastructure investments. This could be particularly beneficial in certain areas where the replacement cost for gas infrastructure is high, thus indicating an electrification solution is beneficial, but the electric grid is also somewhat constrained and the improved efficiency of the heat pumps using the thermal energy network is highly desirable.

Evolution of Customer-Facing Programs to Incentivize Electrification

Many states across the country have started to adapt their energy efficiency and demand-side management programs to incorporate incentives for electrification of building end-uses such as the installation of heat pumps. A notable example in response to both statutory changes and technological developments has been the 2022 to 2024 energy efficiency programs in Massachusetts, which contained significant incentives for heat pumps for a wide range of customers (Walton 2022). More recently, the Colorado Public Utilities Commission has considered a range of related issues for electrification incentives in the context of the Xcel Clean Heat Plan, including fair levels for rebates and cost allocation across electric and gas ratepayers (Colorado PUC 2024b).

Use Planning Analysis to Improve Cost Allocation

- *Improve cost allocation with analysis of benefits*. An integrated planning process can be used to generate information to inform cost allocation and cost recovery across rate cases and programs. In particular, one general approach for cost allocation is "costs follow the benefits." The evaluation of scenarios and alternative utility action plans in the planning process can be used to estimate benefits to different groups, whether that is across electric and gas utility ratepayers or across customer classes for specific fuels. See the callout box for an example of using targeted electrification to improve affordability.
- *Consider repurposing funds across fuels and programs*. Depending on the utility structure and program funding rules in a particular jurisdiction, it may be possible to repurpose funds across systems and programs. This could take several different forms depending on the structure of utility ownership in a given jurisdiction. For example, the avoided costs of a gas system investment can be used to fund the alternative measures chosen and spread across electric and gas ratepayers in a reasonable proportion. The California Public Utilities Commission recently ordered Pacific Gas & Electric, a dual-fuel utility, to redirect funds intended for replacement of gas services and equipment to support electrification programs, eliminating the need for gas main replacement and the costs associated with replacing that infrastructure. Instead, the commission directed the utility to put those funds into a special program that supports and incents transitioning customer energy usage from gas to electric (California PUC 2023, p. 901). A different arrangement has been reached in Québec between Hydro Québec, the major electric utility, and Énergir, a gas utility. This program supports hybrid electric-gas heating conversion, with the goal of using gas heat during winter peak hours to contain electric system costs (Hydro Québec n.d.). Hydro Québec compensates Énergir in recognition of this system contribution and recovers those costs from its electric ratepayers (Montreal Gazette 2022).

Use Integrated Planning Data to Improve Affordability Programs

- *Use combined utility billing data to improve low-income programs and evaluation of rate design alternatives*. Finally, joint planning efforts could be used to help design improved affordability programs. Lack of data on customer combined fuel expenditures is often a barrier to more targeted programs to relieve low- and moderate-income customers from high energy burdens. Unless one integrated utility provides both fuels to that customer, it is hard to match bills to create overall estimates of energy burdens for individual customers and sharing data across companies traditionally raises privacy concerns as well. However, joint efforts in an integrated setting may provide new opportunities for better data and effective collaboration on this topic, both with respect to affordability programs and evaluating rate design alternatives.

Avoiding Unnecessary Gas System Investment: Targeted Electrification Efforts Need Transparent Electric System Data and Holistic Evaluation

Given rising levels of gas system distribution investment (American Gas Association 2023) and potential throughput declines in the future, many jurisdictions are concerned about the potential for significantly increased rates for consumers or stranded costs for utility shareholders (California Energy Commission 2020). Jurisdictions around the country are now exploring the best ways to reduce and prioritize investment or find cost-effective alternative solutions to ensure that customers receive reliable and affordable energy services (Strategen 2023a). Several states, including New York, Colorado, Massachusetts, and Rhode Island, now require gas utilities to examine non-pipeline alternatives to capacity upgrades generally (Strategen 2023a, Massachusetts DPU 2023). New York and Massachusetts also require utilities to consider whether segments of leak-prone pipe should be retired instead of replaced (New York DPS 2022, Massachusetts DPU 2023).

Robust disclosure of electric system distribution capacity data and consumption forecasts can enable targeted electrification programs to address gas system issues. Targeted electrification could either avoid gas capacity upgrades or enable gas segment retirements. In the case of a segment retirement, all current end uses that depend on gas delivered by pipe must be converted to other energy sources, such as air- or ground-source heat pumps or delivered propane. Recent studies in California have found that targeted electrification and decommissioning are more cost-effective than pipeline replacement but noted several challenges to achieving this result in practice. (E3, Gridworks, and Ava Community Energy 2023; E3 2024; California Energy Commission 2024). A recently passed California statute allows for up to 30 “neighborhood decarbonization zone” pilots by 2030. (California Legislature 2024). As of mid-2024, Pacific Gas & Electric in California had completed 88 targeted electrification projects that included decommissioning 22 miles of transmission pipe (Rocky Mountain Institute and National Grid 2024). In addition, a larger Pacific Gas & Electric proposal is pending to enable decommissioning of eight miles of distribution pipeline serving numerous housing units and campus buildings at California State University Monterey Bay (California PUC 2024).

Targeted electrification programs that reduce gas system investments require sufficient electric system capacity—at the local line transformer level, at the substation and circuit level, and at the bulk system level—in the same time frame as the gas system deferral. In addition to gas system considerations, gas system planners must be able to see whether a given area has sufficient electric capacity. Additional information on the cost of electric system upgrades or non-wires alternatives could influence whether a targeted electrification solution is feasible or cost-effective. Central Hudson Gas & Electric in New York proposed this approach in its gas long-term plan filing in February 2024 (Central Hudson Gas & Electric 2024, pp. 4–5.)

6. Conclusion and Next Steps

Utilities and regulators generally have not found it necessary to consider linkages between electric and gas distribution system planning in the past. Building electrification, particularly customers switching from gas-fueled end uses to electric ones, will create simultaneous impacts on the two systems and will require integration of electric and gas planning. Such electrification is expected to accelerate in coming years, and it would be prudent for state policymakers to prepare now. The benefits of integrated planning processes for electric and gas do not accrue only to states with ambitious electrification policy objectives. A case can be made that these advanced planning processes are even more important for states where changes in customer consumption are driven mostly by organic customer electrification preferences. The scale of change in these states, and the customer cost and affordability implications, are more difficult to anticipate and could result in large imprudent investments without an integrated planning approach.

As in many other areas of public policy, regulators may want to walk before they run, and so integration of electric and gas planning will likely be done deliberately over time. Many jurisdictions will continue to work on their electric and gas planning processes within each silo, which may provide initial opportunities to pave the way for integrated planning. These initial steps to coordinate electric and gas planning may include:

- Asking similar questions about underlying inputs and comparing forecasts across planning proceedings
- Adjusting the sequencing of planning filings across each silo
- Aligning the formatting and other aspects of public data disclosures across systems
- Requiring dedicated communications channels and periodic meetings between electric and gas utilities that share service territories.

Next, public utility commissions can open a docket on integrated electric and gas planning with all jurisdictional electric and gas utilities as mandatory parties and the inclusion of other government entities and stakeholders. This docket would scope issues around integrated electric and gas planning, convene stakeholder discussions, and begin creating a record for future decision-making. This should include an evaluation of the commission's current statutory authority to implement integrated planning and whether statutory changes would be necessary or beneficial on certain issues.

We expect that policymakers will continue to grapple with broader structures for the future of energy services throughout the 21st century, just as they did from 1900 to 2000. Integrated electric and gas planning is part of a broader swath of regulatory reforms that will be necessary to efficiently and fairly achieve goals for the cost-effective provision of clean and reliable energy services.

References

American Gas Association. 2023. “Gas Utility Construction Expenditures by Type of Facility.” https://www.aga.org/wp-content/uploads/2023/01/Table12-1.pdf.

Biewald, Bruce, Devi Glick, Shelley Kwok, Kenji Takahashi, Juan Pablo Carvallo, and Lisa Schwartz. 2024. *Best Practices in Integrated Resource Planning*. Synapse Energy Economics and Berkeley Lab, originally published November 2024 and revised December 6, 2024. https://emp.lbl.gov/publications/best-practices-integrated-resource

British Columbia Utilities Commission (BCUC). 2022. “BCUC Energy Scenarios for BC Hydro and FEI.” https://www.bcuc.com/OurWork/ViewProceeding?applicationid=959.

British Columbia Utilities Commission (BCUC). 2024. *2021 Integrated Resource Plan: Decision and Order G-58-24*. March 6, 2024. https://docs.bcuc.com/documents/other/2024/doc_76260_g-58-24-bch-2021irp-decision.pdf.

California Energy Commission. 2020. *The Challenge of Retail Gas in California’s Low-Carbon Future*. Publication CEC-500-2019-055-F. https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-055-F.pdf.

California Energy Commission. 2024. *An Analytical Framework for Targeted Electrification and Strategic Gas Decommissioning: Identifying Potential Pilot Sites in Northern California’s East Bay Region.* June 2024. Publication CEC-500-2024-073. https://www.energy.ca.gov/sites/default/files/2024-06/CEC-500-2024-073.pdf.

California Energy Commission. n.d. “Integrated Energy Policy Report – IEPR.” https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report.

California Gas and Electric Utilities. 2022. *2022 California Gas Report*. https://www.socalgas.com/sites/default/files/Joint_Utility_Biennial_Comprehensive_California_Gas_Report_2022.pdf.

California Legislature. 2024. Senate Bill 1221: Gas corporations: ceasing service: priority neighborhood decarbonization zones. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB1221.

California Public Utilities Commission (PUC). 2023. Decision on Test Year 2023 General Rate Case for Pacific Gas and Electric Company, November 17, 2023. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M520/K896/520896345.pdf.

California Public Utilities Commission (PUC). 2024. Application of Pacific Gas and Electric Company for Approval of Zonal Electrification Pilot Project (U39G), Status Report of Pacific Gas and Electric Company, November 15, 2024. https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M546/K542/546542682.PDF.

Central Hudson Gas and Electric. 2024. *Gas System: Long Term Plan*. February 6, 2024. https://www.cenhud.com/globalassets/pdf/my-energy/energy-in-transition/ch_gsltp.pdf.

Colorado Mesa University. 2024. “Geo-Grid System.” https://www.coloradomesa.edu/sustainability/initiatives/geo-grid.html.

Colorado Public Utilities Commission (PUC). 2024a. Decision C24-0092: Commission Decision Addressing Adequacy Of Gas Infrastructure Plan And Providing Guidance For Future Gas Infrastructure Plan Filings. Feb. 23, 2024. https://www.dora.state.co.us/pls/efi/EFI_Search_UI.Show_Decision?p_session_id=&p_dec=30670.

Colorado Public Utilities Commission (PUC). 2024b. Decision C24-0397: Commission Decision Granting Application With Modifications, Requiring Filings, and Issuing Certain Directives To Guide Next Clean Heat Plan Filing, Jun. 10, 2024 Docket No. 23A-0392EG. https://www.dora.state.co.us/pls/efi/EFI_Search_UI.Show_Decision?p_session_id=&p_dec=30982 .

Consolidated Edison Company (ConEdison). 2022. *Long-Range Plan: An Integrated View of Our Energy System Through 2050*. January 2022. https://cdne-dcxprod-sitecore.azureedge.net/-/media/files/coned/documents/our-energy-future/our-energy-projects/integrated-long-range-plan.pdf?rev=e19f632ec1874af4b67fe57e52f93fb7.

E3, GridWorks, and Ava Community Energy. 2023. *Benefit-Cost Analysis of Targeted Electrification and Gas Decommissioning in California*. https://www.ethree.com/wp-content/uploads/2023/12/E3_Benefit-Cost-Analysis-of-Targeted-Electrification-and-Gas-Decommissioning-in-California_u.pdf.

E3. 2024. "Avoiding Gas Distribution Pipeline Replacement Through Targeted Electrification in California." https://www.ethree.com/wp-content/uploads/2024/06/Gas-Decommissioning-Fact-Sheet-2024-06-18.pdf.

Edison Electric Institute. 2024. "Projected Functional CapEx." Updated July 2024. https://www.eei.org/-/media/Project/EEI/Documents/Issues-and-Policy/Finance-And-Tax/Industry-Capital-Expenditures.pdf?la=en&hash=ED29F5298EF389A7876D96EEA7613C59C2D00881.

Edmondson, Amy, Sujin Jang, and Tiziana Casciaro. 2019. "Cross-Silo Leadership." *Harvard Business Review*, May-June 2019. https://hbr.org/2019/05/cross-silo-leadership.

Elmallah, Salma, Anna M. Brockway, and Duncan Callaway. 2022. "Can distribution grid infrastructure accommodate residential electrification and electric vehicle adoption in Northern California?" 2022 *Environ. Res.: Infrastruct. Sustain.* **2** 045005. https://iopscience.iop.org/article/10.1088/2634-4505/ac949c.

Eversource. 2024a. *Electric Sector Modernization Plan*. January 2024. DPU 24-10. https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/18550443.

Eversource. 2024b. Integrated Energy Planning presentation to National Association of Regulatory Utility Commissioners Task Force on Natural Gas Resource Planning. June 26, 2024. https://pubs.naruc.org/pub/C03F440C-D93F-1746-1B4D-87DF988E4469?_gl=1*gojvw1*_ga*MjEwNDAyNDUxNi4xNzA3MzE4MTgx*_ga_QLH1N3Q1NF*MTcyMTA1ODUzOC42NC4xLjE3MjEwNTg2ODIuMC4wLjA.

Eversource. n.d. "Networked Geothermal Pilot." Accessed December 10, 2024. https://www.eversource.com/content/residential/save-money-energy/clean-energy-options/geothermal-energy.

Georgia Public Service Commission (PSC). 2024. Order Adopting Stipulate re: Atlanta Gas Light Company's 2025-2034 Integrated Capacity and Delivery Plan, July 2024. https://psc.ga.gov/search/facts-document/?documentId=219236.

Geothermal Technologies Office. 2023. "Community Geothermal Heating and Cooling Design and Deployment." https://www.energy.gov/eere/geothermal/community-geothermal-heating-and-cooling-design-and-deployment.

Goldman, Charles, G. Alan Comnes, John Busch, and Stephen Wiel. 1993. *Primer on Gas Integrated Resource Planning*. December 1993. Lawrence Berkeley National Laboratory on behalf of the National Association of Regulatory Utility Commissioners.

GridLab. 2019. *Integrated Distribution Planning – A Path Forward*. https://gridlab.org/wp-content/uploads/2019/04/IDPWhitepaper_GridLab-1.pdf.

Gridworks. 2021. Gas Resource and Infrastructure Planning for California: A Proposed Approach to Long-Term Gas Planning, January 2021, https://gridworks.org/wp-content/uploads/2021/01/CA_Gas_Resource_Infrastructure_Plan_Report_FINAL.pdf.

Grid Modernization Advisory Council. 2023. *Observations and Recommendations of the Grid Modernization Advisory Council Regarding the Electric Distribution Companies' Electric-Sector Modernization Plans*, November 20, 2023. https://www.mass.gov/doc/gmac-final-report/download.

Hirst, Eric. 1992. *A Good Integrated Resource Plan: Guidelines for Electric Utilities and Regulators*. Oak Ridge National Laboratory. December 1992. https://www.osti.gov/servlets/purl/10129845.

Hydro Québec. n.d. "Dual Energy for Sustainable Decarbonization." Accessed December 10, 2024. https://www.hydroquebec.com/residential/energy-wise/windows-heating-air-conditioning/dual-energy-offer/.

Lawrence Berkeley National Laboratory. n.d. "Integrated Distribution System Planning." Accessed December 10, 2024. https://emp.lbl.gov/projects/integrated-distribution-system-planning.

Maine Revised Statutes 35-A § 3146. Integrated Grid Planning. https://legislature.maine.gov/statutes/35-a/title35-Asec3147.html

Massachusetts Clean Energy. n.d. "Massachusetts Clean Energy." (homepage) Accessed December 10, 2024. https://macleanenergy.com/.

Massachusetts Department of Public Utilities (DPU). 2023. Order on Regulatory Principles and Framework, DPU 20-80. December 6, 2023. https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/18297602.

Massachusetts Department of Public Utilities (DPU). 2020. Order on General Increase in Base Distribution Rates for Gas Service and a Performance Based Ratemaking Mechanism, DPU 19-120. October 30, 2020. https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/12834214

Massachusetts Executive Office of Energy and Environmental Affairs (EEA). 2020. "MA Decarbonization Roadmap." https://www.mass.gov/info-details/ma-decarbonization-roadmap.

Massachusetts Executive Office of Energy and Environmental Affairs (EEA). 2024. “Healey-Driscoll Administration Establishes Nation’s First Office of Energy Transformation.” March 15, 2024. https://www.mass.gov/news/healey-driscoll-administration-establishes-nations-first-office-of-energy-transformation.

Mid-Atlantic Distributed Resources Initiative. 2019. *Integrated Distribution Planning for Electric Utilities: Guidance for Public Utility Commissions*. October 2019. https://www.madrionline.org/wp-content/uploads/2019/10/MADRI_IDP_Final.pdf.

Minnesota Public Utilities Commission (PUC). 2024. “Public Utilities Commission establishes planning requirements for Minnesota’s gas utilities.” February 23, 2024. https://content.govdelivery.com/bulletins/gd/MNPUBUC-38cab28?wgt_ref=Latest_Press_Releases.

Montreal Gazette. 2022. “Regulator Approves Deal between Hydro-Québec and Énergir.” May 19. https://montrealgazette.com/business/energy/regie-de-lenergie-approves-deal-between-hydro-quebec-and-energir.

Moskovitz, David. 1989. *Profits and Progress Through Least-Cost Planning*, November 1989, https://www.raponline.org/knowledge-center/profits-progress-through-least-cost-planning/.

National Association of Regulatory Utility Commissioners (NARUC), Oct. 1988, Least-Cost Utility Planning: A Handbook for Public Utility Commissioner, Volume 1

National Association of Regulatory Utility Commissioners (NARUC). 2021. *State Approaches to Intervenor Compensation*. Prepared by FTI Consulting, Inc., December 2021. https://pubs.naruc.org/pub/B0D6B1D8-1866-DAAC-99FB-0923FA35ED1E.

National Association of State Energy Officials (NASEO). 2022. *Trends and Highlights from Recent Comprehensive State Energy Plans.* https://www.naseo.org/data/sites/1/documents/publications/Trends%20and%20Highlights%20in%20Comprehensive%20Energy%20Planning_Final.pdf.

New Mexico Public Regulation Commission (PRC). New Mexico Administrative Code Title 17, Chapter 7, Part 4, n.d. Integrated Resource Plans for Gas Utilities. https://www.srca.nm.gov/parts/title17/17.007.0004.html.

New York Department of Public Service (DPS). 2022. Order Adopting Gas System Planning Process. May 12, 2022.

New York Department of Public Service (DPS). 2023a. “PSC Moves Development of Utility Thermal Energy Networks Forward.” September 14, 2023. https://dps.ny.gov/system/files/documents/2023/09/pr23094.pdf.

New York Department of Public Service (DPS). 2023b. National Fuel Gas Long-term Planning Order, Dec. 14, 2023. https://dps.ny.gov/system/files/documents/2023/12/pr-23127.pdf.

NV Energy. 2023. Distributed Energy Resource Plan. https://pucweb1.state.nv.us/PDF/AxImages/DOCKETS_2020_THRU_PRESENT/2023-9/29074.pdf

Oregon Administrative Rule 860-027-0400(3), n.d. OAR 860-027-0400, Integrated Resource Plan Filing, Review, and Update.

Penrod, Emma. 2023. "Xcel, other utilities launch dedicated planning teams to streamline energy transition, boost innovation." Utility Dive, January 25, 2023. https://www.utilitydive.com/news/xcel-srp-planning-teams-integrated-planning/639674/.

Prause, Elaine. 2022. *Modernizing Gas Utility Planning: New Approaches for New Challenges*. Regulatory Assistance Project, September 2022. https://www.raponline.org/wp-content/uploads/2023/09/rap-prause-modernizing-gas-utility-planning-new-approaches-new-challenges-2022-september.pdf

Puget Sound Energy. 2024. "Resource Planning Advisory Group." Accessed December 10, 2024. https://www.cleanenergyplan.pse.com/rpag.

Purdue University. n.d. "State Utility Forecasting Group." Accessed December 10, 2024. https://www.purdue.edu/discoverypark/sufg/about/purpose.php.

Rocky Mountain Institute and National Grid. 2024. *Non-Pipeline Alternatives: Emerging Opportunities in Planning for U.S. Gas System Decarbonization*. https://www.nationalgridus.com/media/pdfs/other/CM9904-RMI_NG-May-2024.pdf.

Sandoval, Ronny, Natalie Mims Frick, and Jeffrey Deason, Planning for Electrification: Guidance on Aligning Gas and Electric Distribution Planning, ACEEE Summer Study Paper, https://www.aceee.org/sites/default/files/proceedings/ssb24/assets/attachments/20240722163115812_27745ab4-5290-461b-8b6d-38892734fbe1.pdf.

Schwartz, Lisa C., Natalie Mims Frick, Sean Murphy, Guillermo Pereira, Jessica Shipley, Josh A. Schellenberg, Alisha Fernandez, 2024 forthcoming, State Requirements for Electric Distribution System Planning, https://emp.lbl.gov/publications/state-requirements-electric.

Shwisberg, Lauren, Mark Dyson, Grant Glazer, Carl Linvill, and Megan Anderson. 2020. *How to Build Clean Energy Portfolios: A Practical Guide to Next-Generation Procurement Practices*. Rocky Mountain Institute. https://rmi.org/how-to-build-ceps/.

Strategen. 2023a. *Non-Pipeline Alternatives to Natural Gas Utility Infrastructure: An Examination of Existing Regulatory Approaches*. November 2023. https://eta-publications.lbl.gov/sites/default/files/non-pipeline_alternatives_to_natural_gas_utility_infrastructure_1_final.pdf.

Strategen. 2023b. *A Regulator's Blueprint for 21st Century Gas Utility Planning*. Prepared by Strategen for Advanced Energy United, December 2023. https://advancedenergyunited.org/hubfs/2023%20Reports/A%20Regulator%E2%80%99s%20Blueprint%20for%2021st%20Century%20Gas%20Utility%20Planning.pdf.

Synapse Energy Economics. 2024. *Avoided Energy Supply Components in New England: 2024 Report.* February 7, 2024. https://www.synapse-energy.com/sites/default/files/AESC%202024.pdf.

U.S. Department of Energy Office of Electricity, 2020, *Modern Distribution Grid: Strategy & Implementation Guidebook*. https://gridarchitecture.pnnl.gov/media/Modern-Distribution-Grid_Volume_IV_v1_0_draft.pdf.

Vermont Department of Public Service (DPS). 2023. *Guidance for Integrated Resource Plans and 202(f) Determination Requests*. https://publicservice.vermont.gov/sites/dps/files/documents/Guidance%20for%20Integrated%2

0Resource%20Plans%20and%20202%28f%29%20Determination%20Requests%20-%20April%202023.pdf.

Walton, Robert. 2022. "Massachusetts approves $4B efficiency plan. Is it 'transformational' or a 'missed opportunity' on equity?" Utility Dive, February 4, 2022. https://www.utilitydive.com/news/massachusetts-approves-4b-efficiency-plan-is-it-transformational-or-a/618313/.

Washington State Legislature. n.d. Washington Administrative Code 480-90-238 – Integrated resource planning. https://app.leg.wa.gov/WAC/default.aspx?cite=480-90-238.

Washington State Legislature. 2024. Chapter 351, Laws of 2024, Large Combination Utilities – Decarbonization, https://app.leg.wa.gov/billsummary?BillNumber=1589&Year=2023&Initiative=false.