Natural Gas Infrastructure Adequacy in the Western Interconnection: An Electric System Perspective

Phase 1 Interim Report Executive Summary

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Technical Advisory Group

This study was overseen by a group of advisory members:

- Beth Musich, Southern California Gas/San Diego Gas & Electric
- Clint Kalich, Avista Corporation
- Chris Worley, Colorado Energy Office
- Jan Caldwell, Williams Northwest Pipeline
- Jim Wilde, Arizona Public Service Company
- Melissa Jones, California Energy Commission
- Mia Vu, Pacific Gas & Electric
- Peter Larsen, Lawrence Berkeley National Laboratory
- Alaine Ginocchio, Western Interstate Energy Board (WIEB)
- Steve Ellenbecker, WIEB
- Thomas Carr, WIEB

Throughout the study, the TAG provided invaluable feedback and guidance that shaped the scope, results, and conclusions of this study. However, all decisions regarding the analysis were made by E3 and DNV GL. E3 and DNV GL are solely responsible for the contents of this report, and for the data, assumptions methodologies and results described herein.
Pipeline Working Group

This study also benefitted from the contributions and review of representatives of a number of interstate pipeline and local distribution companies. Participating companies include:

- Kern River Gas Transmission Company
- Kinder Morgan
- Northwest Natural Gas Company
- Pacific Gas & Electric Company
- Questar Pipelines
- Southern California Gas/San Diego Gas & Electric
- Southwest Gas Company
- TransCanada Pipelines Limited
- Transwestern Pipeline Company
- Williams Northwest Pipeline
Executive Summary

This study investigates the adequacy of gas infrastructure in the Western Interconnection to meet the needs of its electric sector. The study is divided into two phases:

**Phase 1.** Will there be adequate natural gas infrastructure (interstate and intrastate), including storage, to meet the needs of the electric industry in the Western Interconnection approximately ten years in the future?

**Phase 2.** Will the gas system have adequate short-term operational flexibility to meet increased volatility in hourly electric industry natural gas demand due to higher penetration of variable renewable resources in the Western Interconnection?

The purpose of investigating these questions is threefold: (1) to focus the regional dialogue on gas-electric coordination issues; (2) to assess the magnitude of potential issues and the regions affected; and (3) to provide guidance to policymakers, regulators, pipeline companies, and electric sector planners on actions that may be needed to overcome potential challenges resulting from the reliance on natural gas for power generation.

In the past two decades, the North American power sector’s reliance on natural gas for electric generation has grown significantly. Low gas prices,
environmental regulations, and improving technologies have all contributed to rapid and sustained investment in new gas-fired power plants across the continent. Natural gas generation has, in many parts of the country, become the default resource for new generation, and the reliability of the power sector has become fundamentally dependent on the ability of natural gas infrastructure to supply gas to generators at the moment it is needed.

This increased reliance on natural gas has recently become a cause for concern. While the natural gas and electricity industries evolved independently, developing different vocabularies, conventions, and standards, they have now become intimately interdependent. Recent events around the country have highlighted challenges and vulnerabilities faced by the power sector in its choice to rely on natural gas:

+ In several parts of the Eastern Interconnection, constraints on natural gas infrastructure have led to local gas shortages and extreme spot market prices during recent winters. New England ISO, New York ISO, and the PJM Interconnection have each experienced events where such constraints prevented natural gas generators from operating when called upon. This systemic issue is primarily a result of the widespread reliance of the natural gas fleet upon interruptible transportation services.

+ In February 2011, cold weather in Texas led to natural gas supply shortages due to wellhead “freeze-offs.” Reduced production from the Permian and San Juan basins played a contributing role in the loss of firm electric load in Texas and portions of the Desert Southwest and also resulted in a substantial reduction in the volume of gas flowing to California.
In February 2014, Southern California Gas curtailed a number of non-core customers—including electric generators—in response to supply shortages at the California border. The shortage of gas at the border resulted from a continent-wide natural gas price surge; in response, shippers with firm contracts to deliver gas to California diverted gas to more profitable markets. While California’s electric reliability was preserved throughout the curtailments, this event provides a recent reminder of the vulnerability of the electric sector resulting from its reliance on natural gas.

While such concerns have received increased attention in national energy planning forums, the Western Interconnection looks ahead toward a decade of potential changes that could fundamentally alter the nature and magnitude of its reliance upon natural gas. Increasingly stringent federal emissions standards and a growing preference for environmentally preferred resources have accelerated the retirement of Western coal resources. At the same time, many states continue their pursuit of aggressive Renewable Portfolio Standard (RPS) targets; the development of these resources impacts how and when natural gas is needed to ensure electric system reliability.

The Western Interconnection encompasses a broad and diverse geography. In order to evaluate the adequacy of natural gas infrastructure to meet the needs of the electric sector, this study takes a regional approach that divides the Western Interconnection into ten regions to better understand the characteristics of each one (see Figure 1). The geography selected for this study was developed with consideration for a number of factors, including the characteristics of existing natural gas and electric infrastructure, the regulatory authority, and the structure of wholesale markets.
The focus of this study—assessing the long-run ability of gas infrastructure to meet the needs of the electric sector—is inherently tied to the way that gas transportation services are structured and used by the electric sector in each region. Rather than examining whether today’s gas infrastructure will be capable of meeting demand in the long run; this study examines this question through the lens of the interaction between the two sectors.

Most gas in the Western Interconnection is transported on interstate pipelines under the regulatory oversight of the Federal Energy Regulatory Commission.
Since the deregulation of the natural gas industry in the 1980s and ‘90s, these pipelines have acted as “common carriers,” offering unbundled transportation service to any shipper seeking to transport gas subject to its availability. The standard services offered by interstate pipelines fall into two broad categories: “firm service,” under which a shipper reserves capacity for exclusive use on a natural gas pipeline; and “interruptible service,” under which a shipper can transport gas on a day-ahead basis when capacity is otherwise available. These two types of service are differentiated not only by their cost and quality but in the signal that they send to pipelines. As interstate pipelines design and build facilities to meet their obligations under their firm obligations to shippers, the firm contract is the long-run determinant of the sizing of infrastructure under the FERC regulatory model.

From within this framework for regulation emerge the two key vulnerabilities through which, in the long run, natural gas infrastructure could be unable to meet the needs of the electric sector:

1. If electric generators rely on interruptible transportation service to meet their needs, there may be portions of the year in which capacity is not available due to its reserved use by firm shippers; and

2. In the event of a severe infrastructure contingency on the gas system, natural gas pipelines may be incapable of meeting the needs of their firm customers (as well as any users relying on interruptible service).

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1 California’s two intrastate systems, Pacific Gas & Electric and the Southern California Gas Company, are the major exceptions, and are regulated under a different model by the CPUC.
While gas generators might be unable to secure natural gas in these situations, these circumstances alone would not necessarily translate directly to loss of electric load. Electric system operators have a number of tools at their disposal with which they might react to constraints on natural gas infrastructure; these “operational mitigation measures” include scheduling of incremental electrical imports, dispatch of resources with backup fuel, redispach of non-gas resources, and deployment of demand response programs.

Such operational mitigation strategies, whose availability varies by region throughout the West, play a key role in electric system operators’ abilities to respond in real-time to adverse system conditions. As planners, policymakers, and regulators evaluate the vulnerabilities to gas generation and make decisions on the need (or lack thereof) for action or intervention, it is critical to consider the existence of these operational mitigation strategies alongside the vulnerabilities of the gas system. Indeed, in parts of the Western Interconnection, the two are inextricably linked: in portions of the Pacific Northwest, some generators were built with backup fuel capability to ensure their availability for reliability purposes notwithstanding their choice to rely on interruptible service for economic reasons.

The methodology developed for this study evaluates the vulnerabilities described above and compares them against select operational mitigation strategies. The five-step methodology through which this analysis is conducted is illustrated in Figure 2.
To address the uncertainty of the Western Interconnection’s future over the coming decade, this study examines four scenarios intended to capture a broad range of potential conditions. These scenarios are not intended to serve as predictions or forecasts; rather, they serve as instruments for investigating potential and plausible long-term changes to the electric and gas sectors in the Western Interconnection. The four scenarios evaluated include:

1. **Base Case**: a “Reference Case” that reflects current policy and trends in the electric and natural gas sectors.
2. **High Coal Retirements Case**: a scenario in which a large portion of the Western Interconnection’s existing coal generation fleet is retired and replaced with natural gas generation.

3. **High Renewables Case**: a scenario in which utilities pursue renewable investment beyond current statutory targets, displacing gas and other generation resources.

4. **High Exports Case**: a scenario in which new large volumes of gas are exported from the Western Interconnection to meet needs of other countries.

Each scenario comprises assumptions regarding the level of gas demand in end use sectors (residential, commercial and industrial), among the electric generators, and for export to other areas. All four scenarios rely on the same underlying assumptions of end use gas consumption, which reflects limited growth relative to today’s levels of consumption, consistent with historical trends. Changes in the electric sector are studied through production simulation modeling, in which the electric sector’s operations under each scenario are simulated on an hourly basis across the Western Interconnection (see Figure 3). Finally, each scenario makes certain assumptions on the amount of gas to be exported from the Western Interconnection: the first three scenarios assume the level of export remains at historical levels, while the High Exports Case examines the impacts of the growth of exports to Mexico and LNG exports from the Pacific Northwest.
In addition to these scenarios, the study also considers a number of “contingencies”—extreme events that might occur within a scenario—and sensitivities to lend further detail to the characterization of the gas-electric interface in the Western Interconnection.

Through this analysis, this study reaches a number of key conclusions and provides direction for the next steps needed to characterize the issues more fully:

1. **The natural gas and electric industries are deeply linked such that events and conditions in one may have significant impacts on the other.** Over the past decade, the gas and electric industry of the Western Interconnection have become inextricably linked. The electric sector consumes more natural gas than any other in the Western Interconnection, and natural gas accounts for more generation in the
West than any other single fuel. The level of mutual dependence between the two is of such magnitude that they cannot be viewed independently, and their interdependence must be considered in each industry’s operations, regulation, and long-term planning. FERC’s ongoing docket to examine the gas-electric interface has encouraged such coordination and provides a foundation for continued investigation of issues that may emerge in the future.

2. **Under the Base Case, existing gas transportation infrastructure will generally be adequate to meet the regional needs of the electric sector except under extreme winter weather conditions.** The Western Interconnection stands in contrast to the regions in the Eastern Interconnection whose nearly exclusive reliance on interruptible service has caused problems over the past several years. The adequacy of the western gas system to meet electric sector needs results from the fact that it has been designed with consideration for end use and some portion of electric loads—in California as a result of design criteria that consider the state’s total consumption of natural gas, and elsewhere due to the common practice of electric utilities of purchasing firm service to transport fuel on interstate pipelines. However, under certain extreme weather conditions—generally those that exceed a 1-in-10 likelihood—gas infrastructure may be unable to meet the full demands of the electric sector.

3. **Gas generation that does not contract for firm transportation service may be subject to interruption during times of high gas demand.** While this study indicates that the risk of curtailments to gas generation is generally limited to low-probability events, it does highlight the fact that those resources without fuel security through a firm contract may not be able to receive gas under all conditions. This finding is not meant to suggest that all generators should hold firm contracts, but rather that electric sector resource planners should consider this risk alongside the
cost of alternatives in reliability and long-term resource planning. Appropriately assessing this risk requires transparency on the fuel procurement practices of generators throughout each region.

4. **The regions of the Western Interconnection are highly interdependent in their reliance on natural gas transportation and generation infrastructure.** Nowhere is this more clearly illustrated than in the relationship between the Desert Southwest and California. The Desert Southwest is an important source of energy—both natural gas and electricity—for California, and conditions upstream in Arizona and New Mexico can have important ramifications on the availability of both gas and electric power for users California. This relationship highlights the fact that regional planning efforts must not only consider infrastructure within the region but the conditions and market forces in neighboring regions as well.

5. **Interregional coordination will play a key role in responding to gas generation curtailments during extreme weather.** While the interdependence of the West creates a challenge for resource planners who consider regional dynamics, the interconnectedness of the West is also one of its sources of resiliency. When gas infrastructure is constrained in one region, electric system operators may be able to schedule electric imports from their neighbors to avoid loss of electric load. Taking steps to foster coordination of operations—both within and between regions of the West—will help to ensure that constraints on gas infrastructure do not translate to loss of electric load.

6. **Events that affect multiple regions simultaneously may pose a threat to regional reliability.** Electric system operators may not be able to rely on their neighbors for support during local extreme weather if multiple neighboring systems are simultaneously experiencing similar conditions. Similarly, an infrastructure contingency that affects the ability to supply gas to multiple regions simultaneously could cause substantial
operational challenges. Regional planners may want to take steps to ensure that their own systems are capable of withstanding certain types of event without having to rely to a greater extent on imports from neighboring regions. Such contingencies merit further investigation in regional resource planning forums.

7. **Continued growth of the West’s natural gas generation fleet will require expansion of natural gas infrastructure to provide fuel security.** While existing infrastructure is appropriately sized for a world in which natural gas consumption is similar to present-day levels, it will be increasingly strained if new investments in natural gas generation increase any region’s reliance on that fuel. This study’s High Coal Retirements Case highlights the need for infrastructure expansion with continued growth of the Western Interconnection's gas fleet, but multiple additional drivers could result in similar need—for example, higher than anticipated load growth or electrification of other end uses. Because the expansion of gas infrastructure requires advance notice, planners should be attendant to “signposts” that might signal future need for increased gas consumption in the power sector.

8. **The impacts of new large natural gas loads on the adequacy of gas transportation infrastructure will depend on the extent to which those loads rely upon incremental expansions or existing pipelines.** The High Exports Case examined in this study highlights the importance of this factor. Where export volumes receive service through dedicated new capacity, they will not materially impact the adequacy of gas infrastructure to meet the needs of the electric sector in the West. If export volumes are not met through the construction of new facilities, they may have a material impact on local gas generators who rely on interruptible service, creating more competition for gas through interruptible transportation services.
9. Increased coordination between the gas and electric sectors will facilitate the interdependency between the two. While this study’s analysis suggests that the risks of the electric sector to gas curtailments may occur relatively rarely in the Base Case, it nonetheless establishes a need for increased coordination between the gas and electric industries. The future of the electric sector in the Western Interconnection is inherently uncertain. Both regulators and operators would benefit from shared understanding of the two systems and their mutual reliance, facilitating decisions made both in real-time operations and over the long-term as the two industries continue to evolve together.