Today’s Symposium focuses on a topic of increasing importance for America’s energy future: the inter-relationships among the natural gas and the electric power markets and systems in the U.S. The conventional wisdom is that the electric industry will become even more dependent upon natural gas than it has in recent years, and the natural gas industry looks to a future in which significant growth in demand depends upon developments in the power sector.

Over the course of the day, the Symposium presenters and attendees will shine a spotlight on a number of the operational challenges that have begun to arise in different ways in different parts of the country. The Symposium will examine potential solutions and ways to mitigate some of the growing tensions at the interface of these two markets and their infrastructure systems.

My paper sets the context for discussion of more granular topics. It frames the issues by examining the changes underway in each industry, highlights some of the ways that their greater interdependencies are exhibiting strains, and outlines some of the implications for potential changes in the near and long term.

Several features of today’s energy landscape seem clear as we approach these topics: First, the degree to which gas/electric interdependency raises serious challenges for efficient and reliable energy supply varies considerably by region and by type of issue. Second, there are lots of players with very different points of view, not only across business segments, industries and roles, but also within them. Third, the regulatory issues are complicated; while Federal Energy Regulatory Commission (“FERC”) may have responsibility for a broad set of policy issues on electric/gas integration issues, the states not only have strong interests but also in some cases regulatory responsibilities that can affect market participants’ behaviors as well.
Fourth, there is pressure building, and something needs to change. Because two industries will need to revise aspects of their business practices, communications, relationships, and so forth, change will surely be uncomfortable. We shouldn’t let that discomfort put us in a position of gridlock, such that we find ourselves in a situation in the future where some crisis or emergency occurs and ends up propelling an immediate but reactive response that poorly or inefficiently addresses the needed changes.

And last but not least, as we approach the task of identifying options for addressing the efficiency and reliability challenges for today’s and tomorrow’s electric and gas systems, we should be mindful of the extent to which today’s ways of doing business are grounded in assumptions about communications/information technology systems of the past, as well as tariffs, terms and conditions built on yesterday’s investment requirements rather than current conditions. We should attempt to address changes for tomorrow’s systems and needs, not yesterday’s.

**Changes leading to greater gas/electric system interdependency:**

Many factors have converged over more than a decade to make the operations of the electric sector and natural gas sectors more closely connected. For years, these two systems developed on largely different paths, from a physical, economic, engineering, institutional, industrial-organization, and regulatory perspective (among others). There have been points in time, of course, during which many parallels existed among the two industries: Both evolved through some degree of vertical integration, with aspects of each industry’s value chain regulated as monopolies by federal and/or state governments. The interconnected networks of each industry expanded over larger and larger geographic footprints. Both systems have undergone eras of significant industry restructuring, with new players emerging as functions became more unbundled and as competition began to make its way into different parts of the business.

Today, each industry has its own set of cost structures, operating protocols and standards, commercial instruments, pricing arrangements, and so forth. Even so, over the past two decades and especially in the past few years, the two industries’ systems have become more closely intertwined, with the future of each expected to become increasingly dependent on the other’s. These changes have occurred in parallel with dynamic developments in real-time, internet-based communications systems, which both affect and complicate the interdependencies and may also allow opportunities for new arrangements and solutions.
The U.S. Natural Gas System

Today's natural gas industry spans a diverse array of business segments, different market/regulatory regimes, and different types of companies touching one part or another of the system. At one end are large and small natural gas (and oil/gas) companies, service companies and others involved in exploration, drilling and production of natural gas. Other players along the value chain include companies involved in gathering and processing the gas; commodity marketers and traders arranging a variety of transactions; companies owning the interstate pipeline systems that move product for shippers. Some companies own and operate gas storage facilities; others own and operate LNG facilities. Local gas distribution (“LDC”) utilities receive gas off the interstate pipeline system’s citygate, resell it as a bundled product to retail customers, and provide transportation services to some end users (like power plant owners) who buy gas directly from a third party and ship it to their site across others’ pipelines.

The current system infrastructure retains much of the historical ‘geography’ of natural gas, with production in the Gulf States and southern Plains, linked up to big natural gas market and consumer centers in the Midwest, MidAtlantic/Northeast, and California areas. As natural gas production has come on line in the Rockies and most recently in Appalachian basins, new pipeline and storage projects have been added over the years (as shown in the Figure 1, below).

The build-out of this interstate system was fostered in part by early legislation giving FERC (then the Federal Power Commission) authority to approve both the tariffs and siting of interstate gas pipelines. Since the late 1970s, Congress and FERC (and the Commodity Futures Trading Commission) have taken steps to create a single national physical and financial natural gas market, with commodity prices being set in highly competitive markets and gas pipelines being more strongly regulated. There remains little genuine vertical integration in the gas business after the industry underwent a restructuring to allow for open access to pipeline services and for the separation of marketing/ownership of commodity products from transportation services. FERC continues to regulate interstate gas pipelines, with investor-owned LDC services (and rates) being set by state utility regulators.
Pipeline expansion has traditionally been supported by firm gas customers (e.g., LDCs, some vertically integrated electric utilities that own power plants). Many other users (including competitive power plants and industrial customers) buy gas through interruptible commodity and transportation services that take advantage of underutilized pipeline and storage capacity in some parts of the system. FERC-regulated pipeline service allows for access under tariffed terms and conditions, with the ability of the pipeline companies to provide discounts and other arrangements to meet market needs.

Today, natural gas still tends to move long distances from production sources to users’ sites, typically to locations where there is little to no storage close to or at the end-user’s property. This means that from an operational point of view, gas needs to move “just in time” to the end user through pipelines that in some locations (e.g., the MidAtlantic/Northeast) become quite congested with firm gas deliveries.

The gas market has changed considerably in the past 15 years. At the end of the 1990s, several factors led to gas gaining a larger role in the electric industry. These included changes in fundamental economics of power generation technology and fuel prices, pressure to allow competition into the generation segment of the electric industry and
removal of Fuel Use Act restrictions on the use of gas for power generation. These and other conditions led to a significant increase in additions of natural gas-fired generating capacity starting around 2000, after a half-century in which coal and nuclear plants had dominated power plant capacity additions. (See Figure 2.)

![Figure 2](http://www.power-eng.com/articles/print/volume-115/issue-10/departments/generating-buzz/us-generating-capacity-additions-since-world-war-ii.html)

The boost in demand for gas from the power sector that followed the 1999-2003 power plant investment cycle contributed (along with declining production curves in conventional gas fields in North America) to high and highly volatile natural gas prices in the first half of the last decade. (See Figure 3.) These prices attracted investment in LNG gasification terminals as well as attempts to open up unconventional gas basins through the application of new technology. And these prices also led to significant underutilization of the natural gas combined-cycle capacity that was then in place in many parts of the country.
These conditions eventually fostered development of many gas-rich unconventional hydrocarbon basins that became economically viable through new applications of technologies such as directional drilling and hydraulic fracturing. Accessing such supplies (such as in Texas’ Barnett and Eagle Ford areas, in the Rockies, and in the Marcellus and Utica of the Appalachian region) has helped to dramatically push down natural gas commodity prices since 2008 (Figure 3), to create an outlook for relatively low prices in the future (Figure 4), and to increase the amount of natural gas used for power generation (see Figure 5). In fact, in the past 15 years, the power sector’s use of natural gas has more than doubled, while the level of gas consumed by residential, commercial and industrial customers declined in absolute and relative terms (as shown in Figure 5).
Figure 4

NYMEX Natural Gas Futures Prices - for May 2013 to December 2020
(Henry Hub $/Mcf, with prices as of 4-2008 and 4-2013)

SNL Energy (NYMEX).

Figure 5

U.S. Natural Gas Consumption by End Use (1997-2012)

EIA: [http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm](http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm)
Forecasts for growth in demand for natural gas are driven primarily (although not exclusively) by the power-generation sector (see, for example, the National Petroleum Council’s “Prudent Development,” 2011). But unlike LDCs’ traditional year-round, bundled demand for gas to serve their firm customers, growth in the power sector’s use has not been accompanied by significant expansion in the gas-delivery infrastructure. Without change in some of the key features in current business models for competitive generators or in market rules, that situation is not expected to change dramatically in the near term, making it hard to drive investment in pipeline/storage infrastructure built from power sector support.

**The U.S. Electric Power System**

Although many parallels exist between the natural gas and electric industries and systems, there are many stark differences. For example, historically, electric systems grew up in ways that placed facilities quite close to end-use customers. The fuel used for power generation (e.g., coal, oil, uranium) moved long distances from its source to the power plant. Typically, those power stations had (and still have, in most cases) on-site fuel-storage capability, enabling access to fuel supplies as plants were dispatched on and off to meet instantaneous demands as they changed in real time on the system. Even hydroelectric power, which is often distant from consumer loads, could store its energy (e.g., behind a dam) when the plant wasn’t being dispatched for power.

Over the years, local, small, vertically integrated companies (owning power plants, transmission and distribution) consolidated, creating larger vertically integrated companies. Their footprints were bigger, but they still often retained state regulation over much of the assets in their rate bases. Sales for resale (among the separate affiliates, or between them and third parties) were under FERC jurisdiction. But siting of new generation, transmission, and distribution facilities retained state supervision.

Much has changed over time, especially in the past 15 years as well. As noted in the section above on natural gas, this period witnessed the restructuring of the electric industry to allow greater competition in generation markets, and significant investment in new gas-fired combined cycle power plants. In the past decade, especially, new renewable power plants have also come on line in response to state renewable portfolio standards, federal tax incentives, and that period of high natural gas prices mid-decade. (See Figure 2.) As gas prices fluctuated over the last ten years, natural-gas-fired
generation has been the swing fuel in many respects, as that previously underutilized capacity offered options for economic dispatch. In the past few years in particular, natural-gas-fired generation has eroded the long-dominant market share of coal-fired generation. (See Figure 6.) The increasing share of wind (an intermittent energy resource) and natural gas (with its just-in-time delivery of fuel over the pipeline system) means that a larger portion of total generation comes from fuels without significant on-site fuel-storage capability (also sometimes called “limited energy generation resources”).

Figure 6
U.S. Electric Generation by Fuel Type: 1990-2012

EIA, mer_dataT07.02b.

There are significant differences among the regions. Some depend more than others on renewables (including wind) and natural gas as a percentage of capacity and energy (Figure 7, showing shares of generation by fuel). For example, New England has a relatively large share of natural gas, as do a few other parts of the country. The regions also vary in terms of their reliance on aging and inefficient coal-fired power plants, the most inefficient of which are already feeling economic pressure from low natural-gas prices. Many coal plants have announced plans for retirements and an additional amount of generating capacity that will retire as the circa-2015 compliance deadlines for the federal Mercury and Air Toxics Rule (see Figure 8 for the announced retirements to date). Retirements will likely be
replaced in large part by natural-gas-fired generating capacity, thus reshaping the region-specific generation shares shown in Figure 7.

**Figure 7**

Electric Generation by Fuel Type and by Region (2012)

EIA, Annual Energy Outlook 2012, Supplemental Tables. In this figure, “Renewables” includes conventional hydro, wind, other.

**Figure 8**

Planned Coal Power Plant Announcements (2012-2022)

SNL Financial
Other regional variations include industry structure and the concentration of power-plant capacity owned by competitive generating companies as compared to vertically integrated utilities. Such differences have implications for gas-fired power plant owners’ willingness to enter into long-term firm gas supply and/or transportation arrangements. In competitive wholesale power markets administered by Regional Transmission Organizations (such as those in the Northeast (NYISO, ISO-NE)), for example, forward-capacity markets do not extend beyond several years, and the jury is still out with regard to whether such markets adequately support sufficient long-term investment in either local gas storage and/or incremental pipeline capacity investment. (For example, nationally, natural gas pipeline capacity additions were the lowest they’ve been since 1997, while those in the Northeast were the highest since then, as shown in Figures 9 and 10.)

In states that have retained vertically integrated electric companies, there may be greater support for such long-term supplies. For example, in Colorado state regulators supported Xcel Energy’s investment in new gas-fired generators to replace retiring coal plants, and approved long-term gas supply contracts with Anadarko as part of the package.

Looking ahead, the Energy Information Administration projects that most new generating capacity added in future years will be either renewables or gas-fired, continuing the trend of recent years of growing generation from “energy-limited” resources. (See Figure 11, showing projected electricity generation by fuel type, through 2030.) Given the outlook for low natural-gas prices going forward, potential new coal-fired or nuclear capacity additions face difficult economic hurdles on top of regulatory ones (e.g., related to new federal environmental regulations affecting new power plants) and other investment challenges.
(e.g., long-term high-level nuclear waste management issues; risks related to national policies limiting greenhouse gas emissions). In many ways, such gas-fired generation and intermittent renewable generation can support each other’s operations, with gas-fired capacity capable of providing operational flexibility to balance the intermittency of wind and solar energy power supply.

Figure 11
Electric Generation by Fuel Type
(2005-2011 Actual; 2012-2030 Projected) (Quad Btus)

EIA, Annual Energy Outlook, 2013.

Issues at the Intersection of Greater Gas/Electric System Interdependency:

Even without the projected increases in such potentially “limited energy generation resources,” the electric and gas systems are already experiencing strains at their intersection. To date, integration issues related to such increased gas-fired (and renewable) generation have been fairly manageable. But market timing and coordination issues, reliability risks, and operational challenges on both the electric and gas systems have begun
to emerge. In some regions, for example, generators need to commit to move gas volumes before knowing whether their offers into organized daily power markets have been accepted; conversely, generators need to offer prices into such energy markets without fully knowing the price of their natural gas. There are other instances where gas customers that have contracted for firm gas supply and transportation service face potential (or real) curtailments as operational conditions change upstream and downstream. Tensions are visible across the business models of different players in the two industries, and in the market rules in different regions.

These tensions have been identified in a number of public forums in the recent past. The National Petroleum Council’s “Prudent Development” report in the Fall of 2011, for example, focused on the need to address harmonization of gas and electric market rules and service arrangements. The North American Electric Reliability Corporation published a special assessment (“A Primer of the Natural Gas and Electric Power Interdependency in the United States”) in December 2011.

The North American Energy Standards Board (“NAESB”) established an gas/electric harmonization committee, which identified a set of issues falling into three clusters:

- Issues on which NAESB should consider develop new standards or modifying existing ones (including market timelines and coordination of scheduling; flexibility in scheduling; and information availability with regard to infrastructure utilization and operating conditions);
- Issues on which policy decisions should precede any action by NAESB; and
- Issues on which commercial service arrangements may be the most appropriate course of action (rather than new standards or new policies).

The FERC technical conferences have elicited comments from a wide variety of stakeholders who identified many of the same issues and themes: mismatched operating schedules; coordination and information sharing, including near-term or real-time power generation forecasts; business-model and planning issues in each of the industries that create chicken-and-egg problems for gas and electric resources and infrastructure. Again, while some of these are issues that may be ripe for addressing by FERC (and/or NAESB), many will benefit from the innovation that may occur as market participants and other players in different regions fashion approaches that work for their particular conditions.

At NARUC meetings, state and federal regulators have had presentations on the results of many gas-electric interdependency studies. NARUC is co-sponsoring preparation of an
analysis of long-term infrastructure requirements for both industries on the Eastern side of the U.S. Many of the regional transmission organizations, such as MISO, NYISO and ISO-NE, have performed assessments and sponsored study groups to examine what types of market-rule changes might be appropriate.

Discussion in these and other forums make several things clear. First, the degree to which these issues raise serious challenges for efficient and reliable energy supply varies considerably by region and by type of issue. There are places, such as New England, where the issues are more urgent than in others. Second, there are lots of players with very different points of view, not only across business segments, industries and roles, but also within them. Third, the regulatory issues are complicated; while FERC may have responsibility for a broad set of policy issues on electric/gas integration issues, the states not only have strong interests but also in some cases regulatory responsibilities that can affect market participants’ behaviors.

Fourth, there is pressure building, and something needs to change. It is hard enough to introduce change into a single industry, where there may be players who perceive themselves as winning or losing from different options for resolving small and large issues. It will undoubtedly be even harder to introduce sensible but meaningful changes affecting market participants in two industries. This will surely be uncomfortable, because both industries will actually need to change how they’re doing things and there will undoubtedly be costs associated with accomplishing changes (even if the changes are needed for efficiency and reliability gains in the future). Among those who may need to change the ways they look at these issues are regulators themselves.

Last but not least: in parallel with the significant changes that have occurred in the structure, operations, markets for natural gas and electricity, there have been transformational – if not revolutionary – changes in information systems and communications networks that support activities throughout the U.S. economy and society. In the same 15-20-year period where dramatic changes have occurred in the electric and gas industries, we have also witnessed: the proliferation of broad user access to high-speed computing capability; the commercialization of the internet, and its capabilities for real-time information sharing; the explosion of information exchanged through online systems and social networking; the development and deployment of advanced electronic-metering systems and other aspects of “smart” devices and software that support not only the operations of electric and gas systems but also connect countless users into those networks in more direct ways that in the past. Even so, there remain variations in use of such
capabilities. There are also gaps between the potential capabilities and widespread dissemination and use of such advanced information systems, on the one hand, and their actual use in companies, system operations, transaction support, and policy/market design, on the other. These gaps and variations exacerbate some of the tensions at the intersection of the gas and electric system operations, but they also create large opportunities for different approaches in the future that could support more efficient and reliable energy systems for Americans.

As we approach the task of identifying options for addressing the efficiency and reliability challenges for today’s and tomorrow’s electric and gas systems, we should be mindful of the extent to which today’s ways of doing business are grounded in assumptions about communications/information technology systems of the past, as well as tariffs, terms and conditions built on yesterday’s assets rather than current conditions.

Today’s Symposium topics grapple with these same topics, with the goal of providing various communities – energy firms, energy users, investors, researchers, policy makers, and standard-setting entities – with frameworks and other approaches to addressing these challenges. Today’s panels will cover:

- Competing claims: Gas and electric scheduling mismatches and capacity release issues;
- Ensuring natural gas availability in the future;
- Coordination and information sharing; and
- Dual modeling of the electric and gas markets and systems.

As we approach these issues, let’s focus on changes that will foster the types of innovations we need to have gas and electric systems that are resilient, efficient and reliable.