Integrating natural gas in US electricity market operations

06/02/2016 - 3.30 pm

MARKET MANAGEMENT OIL & GAS SOFTWARE

Natural gas is gaining an increasing share of the electricity generation market, but coordinating the electricity grid with the gas pipeline network raises operational, organizational and modeling challenges.

Post a comment

Source : Shutterstock

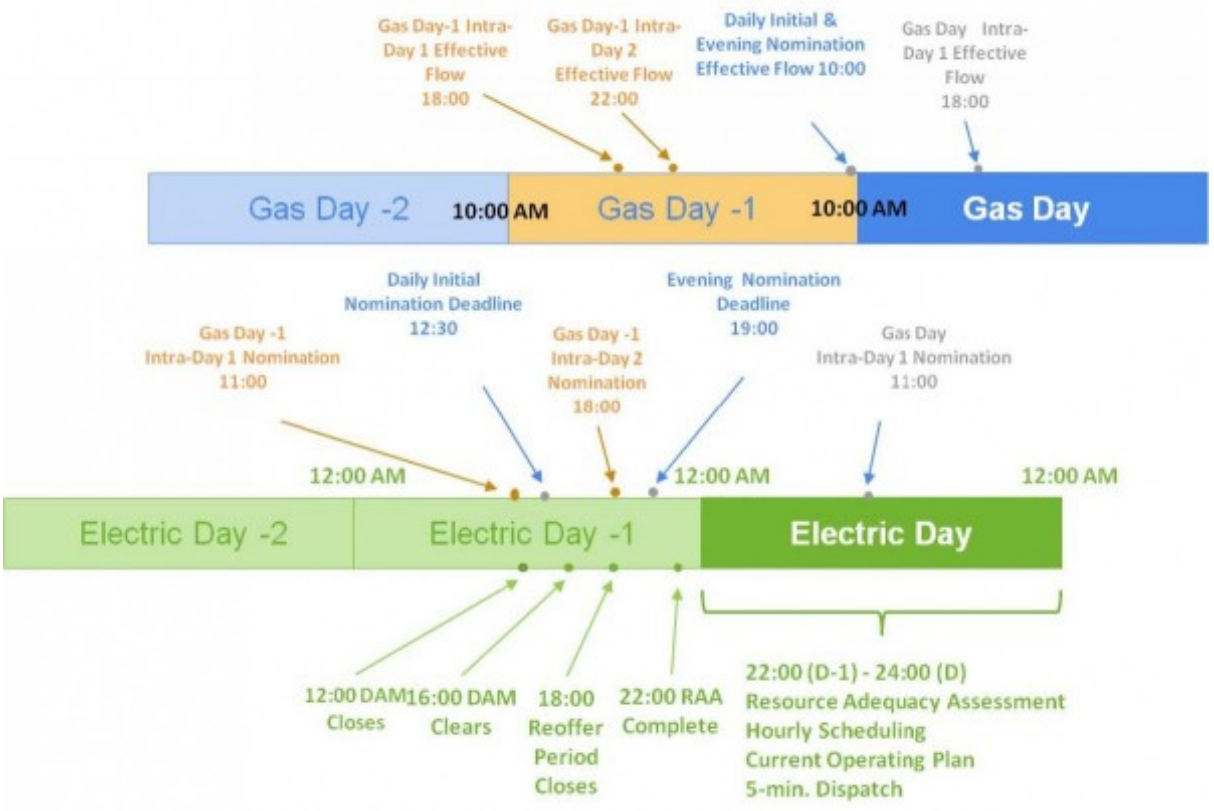
The USA has over 4 million km of natural gas pipelines, supplying 177 million Americans with energy. As well as supplying gas directly to households, the pipelines supply the generators that provide **a third** of the nation's electricity, with gas now the main alternative to replace coal for bulk power generation.

Gas is expected to increase its share of US electricity generation from 27% in 2013 to 31% in 2040. And if gas prices continue to fall, natural gas becomes the leading source of generation by 2020 and accounts for 42% of total generation by 2040 in one **EIA scenario**. As well as ample supplies, gas has technical and environmental advantages. The **efficiency** of a natural gas power plant in the USA is around 40%, compared with some 33% for coal and slightly less for nuclear, while CO_2 emissions are about half. Gas-fired generators also provide the balancing capability to the power system which is much needed by intermittent renewable energy, such as wind and solar.

1 __ Ideal fuel?

It sounds like gas is the ideal fuel, but as Dr. Xing Wang, R&D director at GE Grid Software Solutions points out, it has its drawbacks too. "The most obvious one is that, basically, you can just dump a pile of coal in a power plant's yard and bring in more when stocks start running low. Gas storage possibilities are more complicated, as is its transportation; in practice gas has to be delivered as needed."

Another issue is that the gas and electricity industries do not work on the same time schedule. The natural gas operating day runs from 10 am US Eastern Standard Time of the current day to 10 am the next day. The working day of a large regional transmission organization (RTO), such as PJM Interconnection that covers 13 states, runs from midnight to midnight. This means that power plants get their gas 10 hours after the start of their operating day, and generators have to straddle two "gas days" to cover one "electricity day."



Comparison of Natural Gas and Electric Days

Coordinating the two sectors and making sure that each party has the data it needs will be a priority as the share of natural gas in generation grows. Dr. Wang highlights another complication: "The electricity industry is not the only major gas customer, and demand from households for heating peaks at the same time as demand for generation during cold spells.

2 __ Polar vortex and other risks

Wang cites the winter of 2014 as a case in point. A polar vortex at the start of January drove down temperatures in the PJM area and neighboring areas. This was followed by a series of severe storms lasting through the second half of the month. Scheduling constraints in natural gas markets combined with high demand made it extremely difficult to program gas-fired generation. This

also drove up costs for generators, who had to schedule deliveries and operate at these higher prices.

PJM is not the only RTO facing higher risks associated with increased reliance on natural gas. New England-based Independent System Operator ISO-NE has been working on various initiatives to address the reliability issues associated with gas supply and transportation interruptions. So far it has implemented electricity and gas market:

- "day-ahead" timeline alignment
- improved information sharing with pipeline operations
- intra-day and hourly re-offering capability
- pay-for-performance rules in forward capacity markets.

This provides gas generators with financial incentives to secure fuel arrangements and ensure reliable performance.

3 __All-round expertise needed

But Xing Wang argues that more could be done to address gas-electricity coordination issues and information exchange between pipeline operators and market operators. In his opinion, "it is more a reliability concern than an economic one at this stage and more a 'day-ahead' and 'intra-day' than a 'real-time' concern. Given that, reliability issues need to be addressed by reliability-based incremental unit commitment and de-commitment decisions. Pipeline constraints can be enforced to influence unit commitment solutions, or they can just be monitored to produce warning messages if gas pipeline constraints are violated. In the long run, the two wholesale markets could be co-optimized to further improve efficiency."

GE has the all-round expertise needed to propose a solution, given its experience with both electricity markets and pipelines thanks to the **e-terra** software. The **e-terra***pipeline* software solution answers operators' calls for real-time pipeline state monitoring, modeling and simulation tools for "look-ahead" operations, flow calculation, leak detection and location, and all the other tools needed to ensure safe, reliable and efficient operation. The **e-terra***market* solution is used to manage four out of seven wholesale electricity markets in the USA.

4 __ Saving billions

Xing proposes a hybrid model in which pipeline constraints are added on top of the existing reserve adequacy assessment (RAA) unit commitment model, whose function is to minimize offer price-based unit commitment cost and energy production cost. "You can combine market offer-based unit commitment and dispatch with physical fuel and pipeline topology models to expand market clearing tools to cover gas pipeline contingencies and constraints."

Better integration of gas and electricity markets could save billions. PJM, for example, estimates that natural gas scheduling issues were responsible for most of the extra $597 million charges incurred in January 2014 alone, with the **Department of Energy** noting that these so-called uplift payments are closely related to price divergences between "day-ahead" and "real-time" markets. On a more modest scale, Wang's proposal would allow ISO-NE to simulate different scenarios of pipeline contingencies and extreme gas consumption cases and their impact on market operations and reliability. It would also identify which data from pipeline companies ISO-NE should acquire to improve its own

system reliability and which parts of the pipeline system in the ISO-NE region need expansion.

In the longer term, Xing Wang hopes his work will help to address these two challenges: "Energy systems are becoming increasingly interconnected, but so too are the objectives we are setting them. We have to devise better ways to collect, analyze, understand, and share data among different systems and stakeholders if we want to optimize reliability, price, environmental and other objectives all at the same time."

Shale gas

GE believes that shale gas can be extracted in an environmentally responsible manner, and supports the increased use of natural gas for electricity generation. Other major stakeholders agree, and while a few years ago shale gas was classed as “unconventional,” it now provides the largest share of US natural gas production, while electricity from natural gas surpassed coal in 2015. However, increased reliance on shale gas is raising reliability concerns for electricity grids, particularly during extreme cold weather spells, when demand on gas and electricity peaks with increased risk of natural gas supplies being interrupted.

The latest North American Electric Reliability Corporation (NERC) Long-term Reliability Assessment states that as more gas-fired capacity is added, demand swings from generators could lead to pressure drops in pipelines that subsequently could jeopardize service. In addition, a

switch away from coal to gas reduces the margin of error in the electricity generation system because power plants will be relying on just-in-time supplies of gas rather than having up to a month's supply of coal readily available.

RATE THIS ARTICLE

COMMENTS

SIGN UP FOR OUR NEWSLETTER

LEARN MORE

EXPERTS

Xing Wang

Grid Solutions – R&D Director

SEND A MESSAGE TO OUR EXPERTS