Gas Scheduling in the Northwest

As the Northwest electric system becomes increasingly dependent on natural gas, it is important to understand how the two sectors interface. This informational brief discusses how natural gas is scheduled, what occurs when too much or too little gas is scheduled, and how power plant operators can reduce the risk of not having enough fuel.

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Executive summary

In the Northwest, natural gas serves four major purposes. It heats homes and businesses, powers industrial processes, is a feedstock for producing end products (e.g. fertilizer), and generates electricity. The gas that supplies the Northwest is mostly produced in British Columbia, Alberta, and the US Rocky Mountain region. It is transported to customers through a system of interstate and intrastate pipelines.

Natural gas is not commonly stored on site and moves slowly through pipelines (around 20 mph). As a result, gas is scheduled to be available when needed. Often, a gas user needs more or less gas than scheduled. Under normal circumstances this is not a major issue. But when demand for gas is high, and/or a large quantity of gas is unexpectedly needed, over/under scheduling gas can create a challenging situation.

This brief discusses the basics of gas scheduling, the options available when more/less gas is scheduled than needed, and how power plant operators can reduce fuel risk. It focuses on gas scheduling for electric power plants, but the general concepts are applicable to other gas users as well. This brief was written to help Northwest power system planners and policy makers better understand gas scheduling.

Key takeaways

- With nearly 9,000 MW of nameplate capacity in the Northwest US, natural gas fired power plants are critical to maintaining regional electric power system reliability.

- Thanks to regional pipeline balancing provisions and linepack (gas that always stays in the pipeline to maintain pressure), under non-stressful conditions a gas user can typically use more/less gas than scheduled. This flexibility is further improved on pipelines with gas storage.

- All other factors equal, as pipeline utilization increases, pipeline flexibility decreases.

- There are many options, at different costs, available for power plant operators to reduce fuel risk. These options include having primary firm transportation service, having backup fuel, contracting for storage, and entering into commercial agreements with other gas users.
Players involved in gas scheduling

- The **shipper** owns the gas and utilizes the pipeline system to transport it. Often the shipper is also the gas user (e.g. the power plant operator).

- **Suppliers/supply sources** include gathers/processors which gather and combine the gas from production wells and make it pipeline grade (the processed gas is then sold), intermediary marketers, and storage.

- **Transmission pipelines** (interstate pipelines) transport the gas from receipt points (pick up) to delivery points (drop off). Transmission pipelines do not own the gas, the shipper owns the gas. The major transmission pipelines in the Northwest US and British Columbia are TransCanada GTN, Williams Northwest Pipeline, and Westcoast Energy BC Pipeline (owned by Enbridge).
  
  - There may be multiple transmission pipelines involved to transport gas from the supply source to the gas user. For example, gas produced in Alberta may move through a chain of four pipelines to reach western Washington and Oregon.

- **Direct connect gas users** are industrial and electric generation facilities that are served directly by a transmission pipeline.

- **Local distribution companies (LDCs)** transport gas from the transmission pipeline to gas users inside the LDC’s pipeline distribution system. At a high level, LDC’s have two different customer classes:
  
  - **Transportation customers**, which includes power plants and other large users, schedule gas from the supply source, through the transmission pipelines, and through the LDC to their site.

  - **Sales customers** rely on the LDC to schedule gas along every step of the process. Sales customers include residential and commercial customers (who use gas to heat their homes, cook, etc).
The different transmission pipeline transportation options

Shippers contract with transmission pipelines to receive, transport, and deliver natural gas. There are multiple arrangements for transporting gas on the transmission pipeline system, including:

- **Primary firm transportation** is a contract for a standing reservation for a primary path on the gas pipeline that can be utilized on any gas day, subject to nomination and scheduling timelines, and barring force majeure. The primary path is defined as the transportation path between a specific receipt point (pick up) and a specific delivery point (drop off). Firm transportation is generally the most reliable (and expensive) transportation option.

- **Secondary firm** is provided to a shipper with firm transportation who schedules gas outside of its primary path. This shipper has lower priority than a primary firm shipper, but higher priority than an interruptible shipper.

- **Interruptible transportation** may be available for shippers when firm shippers don’t fully utilize the capacity that has been reserved for them; on a pipeline that does not have firm contracts for all of its capacity; and/or on a pipeline with favorable operating conditions (flow patterns, lower ambient temperatures, etc.) that allow for increased transportation for a limited period of time. However, during high demand days, maintenance periods, or force majeure events, there may only be capacity for shippers with firm transportation. Interruptible transportation is less expensive than firm transportation.

Non-ratable take transportation:

Transportation agreements typically assume that gas will be consumed somewhat evenly throughout the day and/or during traditional on-peak hours. However, some gas-fired power plants only run a few hours per day, especially peaking units that mostly run when prices are high and/or to integrate variable energy resources like wind and solar. Some pipelines in the US offer “non-ratable take” transportation service. This service, which comes at a premium price, allows the shipper to consume their gas when needed rather than over a spread-out time period. In the Northwest, TransCanada GTN recently filed to offer these services to shippers (on GTN it is called Hourly Services and the filing notes that shippers and GTN will be able to agree to a flow rate up to ¼ maximum daily quantity per hour).
Types of natural gas storage

There are generally two types of natural gas storage – liquid natural gas (LNG) storage and underground storage. Gas-users must contract storage to ensure it is available to serve their specific needs. Some pipelines contract for storage to benefit all shippers. However, many pipeline systems are not directly connected to storage and rely on linepack management (gas that always stays in the pipeline to maintain pressure) for dealing with imbalances (shippers needing more/less gas than scheduled).

- **LNG storage** is typically designed to take a long time to refill and is more expensive than underground storage because of power costs to cool the gas. It is reserved for the highest demand days and emergencies when extra gas is needed for reliability.

- **Underground storage** is more versatile than LNG storage. It can be used to supply the system during high demand days and to withdraw/inject gas on a daily basis. The ability to withdraw/inject gas daily helps keep the system balanced and minimizes the impact of imbalances (if too much gas is scheduled, gas can be injected, if too little is scheduled, gas can be withdrawn).

There are two large underground storage facilities in the Northwest, Jackson Prairie and Mist. Jackson Prairie is located on the Williams Northwest Pipeline and Mist is located inside the NW Natural Gas LDC system.

The facilities are beneficial to shippers who have contracted the storage capacity. All of Mist is contracted by individual shippers, and can provide flexibility and peak day capacity to those shippers. Williams Northwest Pipeline has contracted part of Jackson Prairie to benefit all shippers on its pipeline. The remainder of Jackson Prairie is contracted by individual shippers.

*Image from US EIA*


Gas-electric interdependence

Natural gas fired power plants are an integral part of the Northwest electric power system, and the second largest peak capacity resource in the region (following the hydro system). This was not always the case. The region has tripled its natural gas generation nameplate capacity since 2000. And given that many regional planning studies are indicating generation capacity shortfalls in the next five years, natural gas will continue to play an important, and perhaps expanding, role in the Northwest power system. The growing role of gas in the electric sector is not just a Northwest trend – natural gas fired generation nameplate capacity roughly doubled in the US from 2000 to 2015.

For natural gas fired power plants, having enough fuel to meet electric demand is paramount. While some power plants have the option to switch to fuel oil during emergency situations, many are solely reliant on pipelines. As a result, the electric industry in both the Northwest and greater US have become increasingly interested in the natural gas scheduling process. Recently, FERC issued orders seeking to improve gas scheduling for electric power plants. These include Order 809 (2015) which changed the scheduling process for all gas users, and Order 787 (2013) which aimed to improve communications between electric operators and gas pipelines for reliability purposes.

Figure 3
Northwest gas generation by transmission pipeline

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1 PNUCC Northwest Regional Forecast data. Northwest defined as ID, OR, WA, and western MT.
2 US EIA form 860 – “Existing Nameplate and Net Summer Capacity by Energy Source, Producer Type and State.”
3 Some of these units are in a LDC pipeline system – the pipeline listed in the chart is the last transmission pipeline used. Gas may flow through various transmission pipelines before reaching the unit.
Gas scheduling 101 for transmission pipelines

**Step 1 – gas is purchased**

The first step in acquiring natural gas for a power plant is buying the gas. Usually gas is purchased from a processor/gather or a marketer. Often the gas is purchased months or years ahead to reduce fuel availability risk and/or price risk (hedging).

**Step 2 – transportation scheduled**

The second step is to schedule transportation. The owner of the gas must be the shipper on a transmission pipeline. The shipper places a nomination (request for gas transportation) with the pipeline that includes the receipt point, quantity of gas, and the drop off location. Nominations are made during one of five cycles. Most gas is scheduled during the timely nomination cycle. After a nomination is submitted, the pipeline must communicate/confirm with the supplier that supply will be forthcoming and communicate with the gas-user/power plant that the gas will be consumed. After confirmations have been made, the pipeline will schedule the transportation.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Nomination deadline</th>
<th>Schedule issued</th>
<th>Flow starts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely</td>
<td>11:00 AM (day ahead)</td>
<td>3:00 PM (day ahead)</td>
<td>7:00 AM (start of gas day)</td>
</tr>
<tr>
<td>Evening</td>
<td>4:00 PM (day ahead)</td>
<td>7:00 PM (day ahead)</td>
<td></td>
</tr>
</tbody>
</table>

*7:00 AM – Gas Day Starts*

<table>
<thead>
<tr>
<th>Intraday 1</th>
<th>8:00 AM</th>
<th>11:00 AM</th>
<th>12:00 PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraday 2</td>
<td>12:30 PM</td>
<td>3:30 PM</td>
<td>4:00 PM</td>
</tr>
<tr>
<td>Intraday 3</td>
<td>5:00 PM</td>
<td>8:00 PM</td>
<td>8:00 PM</td>
</tr>
</tbody>
</table>

If the shipper has firm pipeline rights from the gas supply location to the power plant, the transportation is guaranteed (provided the gas has been purchased/scheduled properly, and barring force majeure). If the shipper does not have firm pipeline transportation rights, there is a chance they will not be able to transport the gas (the pipeline may be full), and they run the risk of being bumped (superseded) by a firm shipper.

**Step 3 – gas is delivered**

The power plant receives the gas and generates electricity. If the gas is being shipped on multiple pipelines, transportation needs to be arranged on each pipeline. If the power plant is inside a LDC pipeline system, they must make transportation arrangements with the LDC as well (through a similar, but not necessarily identical, process).

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4 30 minutes before the gas schedule is issued is the confirmation
Dealing with imbalances

Electric demand forecasts are not perfect. Sometimes demand will be higher/lower than expected or an emergency will require a unit to start on short notice. The difference between the amount of gas scheduled by a power plant (to meet forecasted demand) and the amount of gas consumed by a power plant (to serve actual demand) is an imbalance. Every pipeline has different rules for resolving imbalances. The rules are usually based on the operational flexibility of the pipeline.

Below are four examples of how shippers and pipelines can resolve imbalances. Each example starts with how imbalances can be resolved under ideal circumstances, and then notes how options may change under stressful conditions. Generally speaking, as pipeline utilization increases, flexibility decreases, and imbalances become more challenging for the pipeline and/or the shipper.¹

1. Shippers can borrow/leave gas in the pipeline by over or under nominating on another day to offset the imbalance. Pipelines can use linepack, or their own storage (if available), to cover the imbalance. Under non-stressful conditions this can be done, to some extent, without advanced notice to the pipeline. Often, imbalances do not need to be corrected right away. For example, the Williams Northwest Pipeline typically allows shippers 45 days to rebalance the pipeline. Generally, the pipeline and the shipper will work together to move the imbalance towards zero.

Each pipeline has a process for handling imbalances during stressful situations. Imbalances may need to be corrected in a short timeframe (e.g. daily), and pipelines may penalize shippers if imbalances become too large.

Stressful days for the pipelines/shippers can be caused by:

- Cold weather that increases demand for natural gas due to increased heating needs
- Unplanned outages on the electric system that cause gas-fired power plants to operate more than expected
- Unplanned outages on the gas system that limits the ability to deliver gas
- Higher than expected demand during a period of pipeline maintenance
- Weather that deviates significantly from the forecast
- Other issues

¹ Flexibility in this report refers to the ability to mitigate an imbalance. Price hub flexibility, a somewhat separate concept, is negatively impacted at both very high and very low utilization levels.
2. Gas can be withdrawn or injected into storage to balance gas demand with scheduled nominations. However, storage only benefits those who have contracted the resource, and not all pipelines are directly connected to storage. Although Williams Northwest Pipeline has secured some storage at Jackson Prairie to benefit all its shippers, most storage in the Northwest is contracted by individual shippers to serve their specific needs.

3. Shippers can net or trade imbalances with other shippers (e.g. buy/sell gas with other shippers). During high demand days, this option may not be available (due to a lack of liquidity), or could come at a premium price.

4. Intraday cycles can be used to adjust gas flow. However, the intraday market is not very liquid, so transactions are not always available. Further, gas scheduled on intraday cycles is subject to available capacity.

Rules adopted by the industry provide that gas is deemed to have flowed as nominated (and confirmed) until the effective time of the requested change. Thus, any change is only effective for the remaining hours in the gas day. This is known as the elapsed pro-rata rule (which is followed by all pipelines in the Northwest).

**Elapsed pro-rata rule example**

A utility nominates 24,000 dth of gas during the Timely nomination cycle (day ahead). But market dynamics change and the utility no longer plans to use the power plant. During the Intraday 1 cycle the utility tells the pipeline that they no longer need any gas. But Intraday 1 starts flowing at 12 PM, and the gas day starts at 7 AM. As a result, utility is still responsible for five hours of gas at an even flow rate, which in this case is 5,000 dth (5/24 * 24,000 dth).

Figure 4 – pacific clock time
Mitigating fuel risk

As discussed in the section above, during high demand days, imbalance flexibility is limited. To ensure reliable access to natural gas, power plant operators can:

- **Hold primary firm pipeline transportation capacity.** By having a dedicate path from gas supply to delivery point, the shipper can ensure that its supply of gas will be delivered, assuming the gas has been purchased and scheduled in a timely manner, and barring force majeure. Many, but not all, gas units in the Northwest have firm pipeline capacity for some or all of their transportation path.

- **Have backup fuel oil.** If an operator is unable to get gas for its power plant, they can switch to oil and keep operating. In the Northwest, some simple-cycle peaking generators have back-up fuel oil. Most of the combined-cycle generators do not have backup fuel available (although many have primary firm transportation). And there can be permitting and air quality restrictions that limit the ability for power plant operators to hold and/or use fuel oil.

- **Contract natural gas storage capacity.** Storage acts like a shock absorber for the shipper, allowing them to more easily adjust nominations, even on high demand days. Storage benefits those who have contracted the capacity, and does not necessarily benefit all shippers. In the Northwest, some power plant operators have contracted for storage as part of their portfolio.

- **Have pre-arranged commercial agreements in place with other shippers.** A power plant operator can pre-arrange agreements that allow them to acquire gas supply and transport from another shipper (with a similar primary reserved path) in an emergency at a premium price.

As discussed above, there are a number of ways to mitigate the risk of not having natural gas during stressful days. All of these options come at an additional cost to the plant operator. Each operator must make its own cost/benefit analysis of these measures for each power plant location and use. In the Northwest, many regulated utilities are incentivized to mitigate fuel risk to maintain a reliable electric power system. Merchant plants, both in the Northwest and in other areas of the country, may not have sufficient incentives to make these fuel risk mitigation measures pencil out (slightly more than 20% of Northwest gas generation is IPP owned).  

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6 PNUCC Northwest Regional Forecast data. Northwest defined as ID, OR, WA, and western MT.