Pipeline Explosion Exposes Refinery Vulnerability

Natural gas fuel interruption shuts Pacific Northwest plants.

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Data Sources for This Publication
U.S. Energy Information Administration
CME Group
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Outage Hits 94% of Washington State Capacity

An Oct. 9 explosion on Enbridge's West Coast Mainline natural gas pipeline disrupted energy markets in the Pacific Northwest two weeks ago. The pipeline ships gas from producing areas in northwest Canada down through British Columbia into the United States, carrying as much as 2.4 billion cubic feet/day to industrial, commercial, and domestic users in Washington State, Oregon, and Idaho. The incident cut off gas supplies across the border into Sumas, Washington, for two days until Enbridge began to restore service through an adjacent line. The disruption caused unplanned outages at four of the five refineries in Washington State, representing 94% of processing capacity supplying Washington and Oregon. The outage caused temporary refined product price spikes and raised questions about the vulnerability of these plants to unexpected gas curtailment. The refinery impact was limited this time because Enbridge restored gas flows rapidly, but that may not always be the case. This note looks at U.S. refinery dependence on natural gas that makes them more competitive but increases their risk of disruption.

Northwest Scare

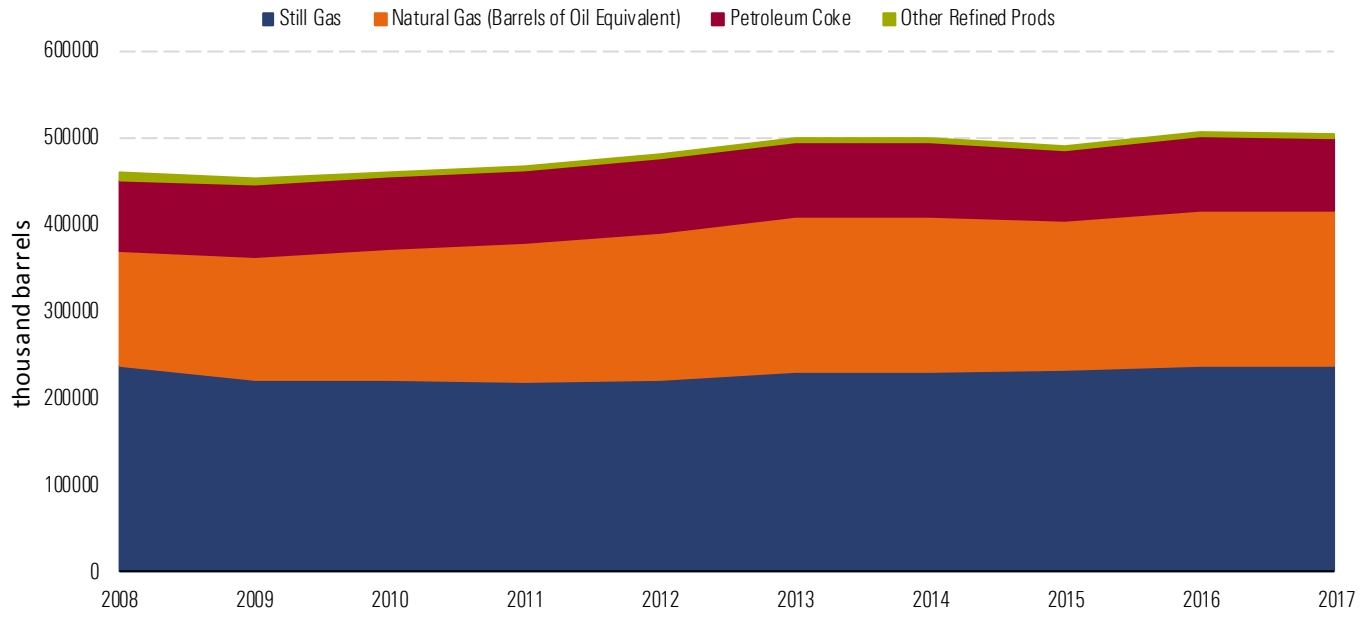
The day after the pipeline outage, Shell shut down units at its Anacortes, Washington, refinery and Phillips 66 shut its nearby Ferndale, Washington, plant. Marathon slowed its Anacortes refinery to run at minimum rates and BP reduced rates on the hydrocracker at its Cherry Point, Washington, refinery. That knocked out or slowed output at four out of five Washington State refineries that have combined capacity of 638 thousand barrels/day (see our January 2017 Outlook "Pacific Northwest Refineries – Cheap Crude and a Captive Market" for more detail on these plants). Of the five refineries, only the smallest, the 41 mb/d Tacoma plant owned by Trailstone, was not affected, meaning that 597 mb/d, or 94% of regional capacity, was shut down. That rapidly caused a supply problem in the Pacific Northwest, which is primarily served by the local refineries and otherwise relies on product shipped from California or imports. The result was a spike in the Portland, Oregon, market, where gasoline prices are set for the northwest region. According to Platts, unleaded gasoline jumped $0.18/gallon in the three days following the pipeline explosion. The return of gas supply two days later allowed refineries to return to normal processing, but the incident highlights a vulnerability in the U.S. refining system.

Refinery Fuel

Refineries primarily use natural gas as a fuel for heating raw crude and semi-finished products at various stages of the production process, from simple distillation to more complex cracking and coking that break down residual oil into transportation fuels. Natural gas is also used as a feedstock to steam methane reformers that make hydrogen, which is used in hydrocrackers, hydrotreaters, and other units that remove sulfur from distillate and gasoline blending components. According to Energy Information

Administration annual data, U.S. refineries used an average of 3.0 billion cubic feet/day of natural gas for refinery fuel and hydrogen production in 2017. That amounts to roughly 4% of total U.S. dry gas production last year, meaning that refineries are significant gas consumers. Exhibit 1 shows EIA refinery fuel data between 2008 and 2017 broken out by category. On average over this period, still gas (a mixture of gases evaporated from crude or products during refinery processing) represented 47% of the total (by volume in thousand barrels), followed by natural gas (shown in thousand barrels of oil equivalent) at 34%, petroleum coke (a byproduct of heavy fuel processing produced by catalytic units or cokers) at 17%, and other refined products at 1%. Refineries in PADD 5, the West Coast region that includes the Pacific Northwest, use more natural gas (39% of total fuel) and less petroleum coke (13%) than the national average. In addition to natural gas, refineries also use electricity from the local grid as a source of power, and they may also generate power and steam from their own operations with a combined heat and power, or CHP, generator. Where refineries do not have access to natural gas as a fuel source, they rely on refined products such as fuel oil and distillate, but using these reduces plant yields and typically costs more than natural gas.

Exhibit 1 United States Refinery Fuel Sources

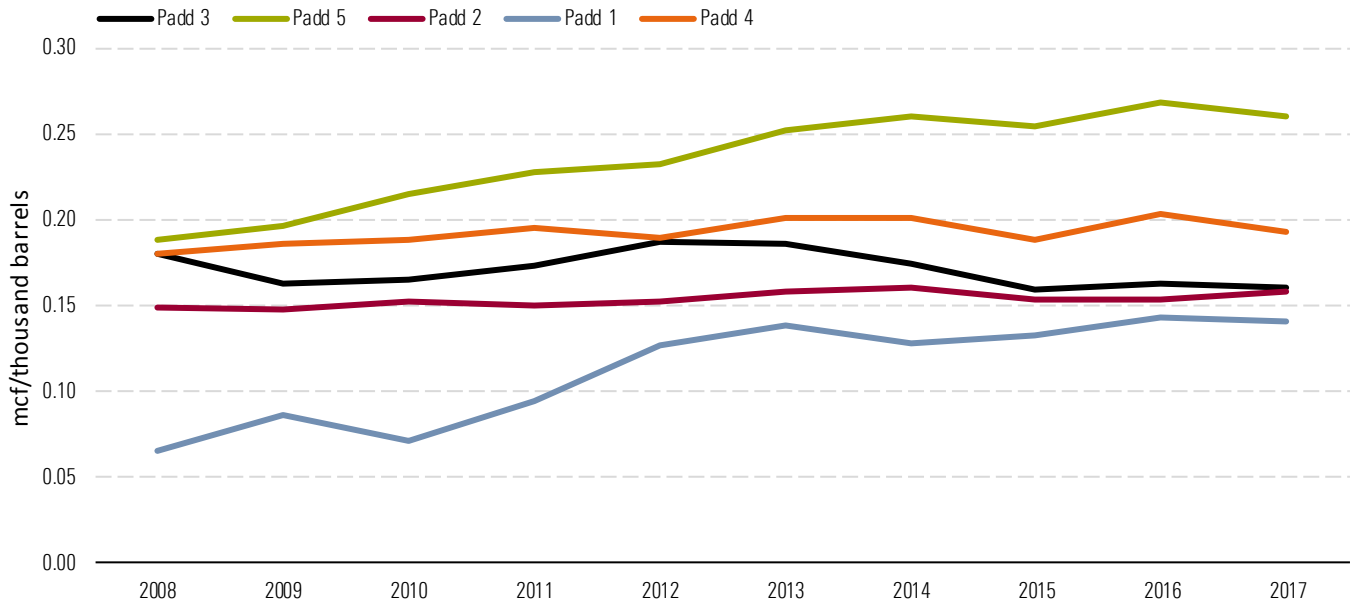


Source: EIA, Morningstar

A closer look at the EIA fuel date shows that West Coast refiners consume natural gas at a higher rate than any other region. Exhibit 2 shows the annual average volume of natural gas (million cubic feet) consumed per thousand barrels of crude processed at refineries in PADD 1 (East Coast – blue line), PADD 2 (Midwest – red), PADD 3 (Gulf Coast – black), PADD 4 (Rockies – orange), and PADD 5 (West Coast - green). West Coast refineries burn more than twice as much natural gas as East Coast plants, probably because California refineries are among the most sophisticated, while only two East Coast

plants process heavy crudes. Natural gas consumption per barrel processed is similar in PADDs 2,3, and 4.

Exhibit 2 Refinery Natural Gas Consumption per Barrel Processed by Region



Source: EIA, Morningstar

Cheap Fuel

An abundant supply of cheap U.S. natural gas during the shale era has played an important role in making domestic refineries competitive in international terms by reducing their fuel costs. The cost of benchmark Henry Hub Louisiana natural gas prompt CME futures in the U.S. averaged $3.17/million British thermal units between 2012 and 2017, less than half the equivalent price of NBP gas futures over the same period in the United Kingdom ($7.56/mmBtu) and average Japan/Korea delivered liquefied natural gas in 2016 and 2017 ($7.33/mmBtu). Many refineries in Europe and Asia don't have access to natural gas and use refined products or crude oil as fuel instead. Lower fuel costs increase U.S. refining margins by at least $1/barrel versus competitors. The lower costs also make U.S. refined product exports more competitive in world markets.

Regional Vulnerability

Although U.S. gas production is at record levels and most regions now have access to pipeline supply, large industrial facilities such as refineries remain vulnerable to pipeline outages. It isn't practical for refineries to store adequate natural gas supplies onsite in case of a pipeline problem. In the Gulf Coast, the extensive network of natural gas pipelines crisscrossing the region probably provides good redundancy. Outside of that region, older natural gas distribution systems are more exposed to the kind of disruption that took out four Washington State refineries this month. In effect, this vulnerability is a trade-off against the lower costs of using natural gas as a refinery fuel. Up until now, pipeline outages

have been considered infrequent enough to discourage refiners from investing in alternative supplies, but events in the Pacific Northwest may cause that risk to be reconsidered.

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