

An hourglass-shaped graphic with a globe inside. The top bulb is dark blue, and the bottom bulb is light blue. The globe is centered in the narrow neck of the hourglass. The top bulb has a dark blue cap. The bottom bulb has a light blue cap.

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Oil and Gas Disruption From Hurricanes Katrina and Rita

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April 6, 2006

Abstract. Hurricanes Katrina and Rita shut down oil and gas production from the Outer Continental Shelf in the Gulf of Mexico, the source for 25% of U.S. crude oil production and 20% of natural gas output. Katrina, which made landfall on August 29, resulted in the shutdown of most crude oil and natural gas production in the Gulf of Mexico, as well as a great deal of refining capacity in Louisiana and Alabama, 554,000 barrels per day of which was still closed as of late October, 2005. Offshore oil and gas production was resuming when Hurricane Rita made landfall on September 24, and an additional 4.8 million barrels per day (mbd) of refining capacity in Texas and nearby Louisiana was closed.

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Oil and Gas Disruption From Hurricanes Katrina and Rita

Summary

Hurricanes Katrina and Rita shut down oil and gas production from the Outer Continental Shelf in the Gulf of Mexico, the source for 25% of U.S. crude oil production and 20% of natural gas output. Katrina, which made landfall on August 29, resulted in the shutdown of most crude oil and natural gas production in the Gulf of Mexico, as well as a great deal of refining capacity in Louisiana and Alabama, 554,000 barrels per day of which was still closed as of late October, 2005. Offshore oil and gas production was resuming when Hurricane Rita made landfall on September 24, and an additional 4.8 million barrels per day (mbd) of refining capacity in Texas and nearby Louisiana was closed.

Combining the effects of both storms, 1.3 mbd of refining — about 8% of national capability — is shut down, reducing the supply of domestically refined fuels commensurately. Much of the refined product shortfall was made up by imports of refined products, some of which were made available by strategic supplies released by International Energy Agency (IEA) member nations on September 2.

As part of the IEA drawdown, 30 million barrels of crude oil were made available from the U.S. Strategic Petroleum Reserve (SPR), which holds only crude. Only 11 million barrels was sold from the SPR, in part because limited refinery capacity reduced the call on crude.

Natural gas production from Gulf of Mexico and Louisiana state lands has been recovering since the storms, but the equivalent of about 3% of U.S. consumption remains shut-in because of production or transport problems. Unlike refined products, which can be imported, there is little extra available supply. A normal storage situation at the start of the heating season — coupled with a very warm winter — saw Spring 2006 arrive with surplus gas in storage and gas prices well below equivalent oil prices.

This report will be updated to reflect significant restoration of gas and oil production and related infrastructure, as well as relevant changes in hydrocarbon supply and demand.

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Oil and Gas Disruption From Hurricanes Katrina and Rita

Overview

Hurricanes Katrina and Rita shut down oil and gas production from the Outer Continental Shelf in the Gulf of Mexico, the source for 25% of U.S. crude oil production and 20% of natural gas output. Katrina, which made landfall on August 29, resulted in the shutdown of most crude oil and natural gas production in the Gulf of Mexico, as well as a great deal of refining capacity in Louisiana and Alabama. Offshore oil and gas production was resuming when Hurricane Rita made landfall on September 24, and an additional 4.8 million barrels per day (mbd) of refining capacity in Texas and nearby Louisiana was closed.

The most profound impacts of the hurricanes were on refined product supply, although natural gas supply to the U.S. pipeline grid is also a concern. At one point, about one-third of the nation's refining capacity was closed. Virtually all have been restored, although output at a couple of units is still in the process of ramping up. Heroic recovery efforts at refineries and increased imports of refined products met a warm heating season's needs and kept gasoline supplies flowing without isolated run-outs.

About 400,000 bd of crude oil from the outer continental shelf (OCS) and Louisiana state lands is currently shut in. This is the equivalent of about 5% of total U.S. petroleum demand. Imported crude has kept stocks at more than adequate levels.

Refined product supplies were initially made up from the release of 30 million barrels of gasoline, middle distillate and other products from the strategic reserves of member nations of the Organization for Economic Cooperation and Development (OECD) who are International Energy Agency (IEA) members. Since those barrels arrived in early fall 2005, the world market private sector has provided the United States with an increased level of imports. Supply appears to have matched demand, as prices fell through late 2005 and early 2006.

A number of crosscurrents bear on this situation, including how fuel demand is affected by prices, and when winter weather arrives and how cold it might be. On the supply side of the relationship are factors which include the rate at which U.S. refining recovers, and the availability on world markets of commercial refined products. In addition, some waivers of gasoline specifications have been granted by the Environmental Protection Agency (EPA), aimed at making gasoline easier to supply.

With natural gas, about 85% of the nation's supply comes from domestic production; there is very little opportunity to import replacement supply. As of October, nearly 10% of total nationwide consumption was shut-in because of production problems in the Federal Offshore Gulf of Mexico, or because of damage to critical infrastructure. Another 3% of nationwide supply from Louisiana state lands is shut-in. Despite reduced output, gas was still being placed in storage; the additions during the week ending October 14 were 75 billion cubic feet (bcf). The amount of gas already in storage was equivalent to the five-year average, although it was slightly below year-earlier levels.

Gas sold from storage is used to balance seasonal demand swings, and not to replace a catastrophic loss of production. Given that the current amount of shut-in OCS and Louisiana state lands gas is the equivalent of half the most recent week's storage addition, the perception of a robust injection to storage should be adjusted accordingly.

Despite the fact that supplies continue to flow, wellhead prices have doubled since last summer. Issues for the onset of cold weather include timing and severity, as with oil, as well as "demand destruction" resulting from higher prices. But if Gulf of Mexico production does not recover, there is no import safety-valve, and supplies could become tight and prices could spike.

In the immediate wake of Katrina and Rita, much of the impacted area was without electric power. But nearly all customers who had been without power in Texas have had service restored. In Louisiana, power outages are more widespread, although many customers listed as being without power are unable to receive it because of damage to the premises.

Hurricane Effects on Crude Oil Production, Imports, and Transportation

Nearly 1.6 mbd of crude oil — the equivalent of 7.6% of U.S. oil consumption — was produced on the Gulf of Mexico Federal Offshore before the hurricanes struck. Production was virtually halted in the wake of both storms, as production facilities were evacuated and wells were shut down. The storms destroyed 111 production platforms, and 52 were seriously damaged. A number of drilling rigs were destroyed, which will limit future production from new wells yet to be completed.

Oil production has begun to resume. Output has begun to ramp-up, reaching 600,000 bd on October 11. But 60% of Gulf of Mexico oil remains shut in, and over 50 million barrels of oil output have been lost since Katrina-related shutdowns began on August 26. The amount of lost output continues to mount, as about 1 mbd of capacity remains shut-in.

Between October 1 and October 7, oil output rose by 300,000 bd, an encouraging sign of restarting operations. But a full assessment of damage to facilities, including underwater production platform-wellhead connections and pipeline gathering systems, has not been completed. It may be too early to assess

whether production is steadily coming back, or if all the production that has come back was the easiest to restore while currently shut-in output presents significant challenges at production platforms, within transport infrastructure, and at coastal processing facilities. Production can come back only as fast as pipelines and processing facilities return to service.

That said, Energy Information Administration (EIA) Administrator Guy Caruso has estimated that shut-in production will continue being restored; the amounts shut-in will likely average 930,000 bd in October, 724,000 bd in November and 517,000 bd in December.¹

In addition to disrupted production, the operation of two important long-distance crude oil pipelines were impeded. CAPLINE, which transports crude from Louisiana to Illinois, was shut for several weeks; it is now operating at 80% capacity. This limited crude supply to a number of refiners in the central part of the nation. And the Sun Pipeline and terminal started limited operations in early October, supplying a number of Texas and Louisiana refineries.

Some pipelines transporting refined products had service outages or throughput reductions as a result of the hurricanes. Most notable was the Colonial Pipeline, which transports fuels from the Gulf northeastward, ending in New York. This is an important source of supply for consumers all along its route, and its outage resulted in very high prices in places like Maryland and Washington, D.C., which at one point had the highest gasoline prices in the nation. Colonial received full commercial electric power on October 13; full capacity is now available, subject to availability of pipeline input. Gasoline prices in its service area are returning to parity with prices elsewhere.

About 2.5 mbd of crude oil imports — including 0.9 mbd by way of the Louisiana Offshore Port (LOOP) — flow through storm-damaged ports in Louisiana, Mississippi, and Alabama. This constitutes more than 12% of petroleum consumption.² LOOP was operating at full capacity when it was shut down again as a precautionary measure in anticipation of Hurricane Rita. It is reportedly operating at 100% capacity, having escaped more damage from Rita. Other Gulf Coast ports through which oil imports flow have resumed operation, except for Port Arthur, which can accept barge traffic only during daylight hours. The Mississippi River is open with some restrictions.

Refineries and Product Pipelines

In the days after Rita, 5.6 mbd of refining capacity was shut — nearly one-third of the nation's total. By mid-October, most of this capacity was operating or in the start-up process. Four facilities were closed in the wake of Hurricane Katrina; one has restarted, and full production is expected at the end of October. Electric power

¹ EIA's *Winter Energy Outlook*, Oct. 12, 2005.

² Ibid.

has recently been restored to three other Louisiana plants which sustained substantial damage, and they are expected to be down for an extended period. They have a combined capacity of 554,000 bd³.

An additional 722,000 bd of capacity shuttered in the wake of Rita remains off-line, leaving a total of 1.3 mbd down as a result of both hurricanes. This represents nearly 8% of national capacity, and presents potentially serious supply problems, given the lack of any spare U.S. refining capacity. Additionally, the shutdown of over 5 mbd of capacity for virtually all of September has affected refined product stocks as seasonal demand starts to grow.

Strategic Petroleum Reserves — Coordinated Release by the U.S. and IEA

On August 31, Secretary of Energy Bodman announced that the Bush Administration was authorizing releases of Strategic Petroleum Reserve (SPR) crude oil. Seven refiners requested loans of crude oil totaling more than 13 million barrels. The release of SPR oil and the announcement on September 2 from the IEA of a coordinated drawdown of 30 million barrels of crude and 30 million barrels of refined products calmed markets by early in the week of September 5.

The U.S. SPR holds crude oil only. The net-importing IEA member countries are required to hold at least 90 days of net imports, and this obligation is met with a combination of crude and refined products. At the end of June 2005, these stocks amounted to 222 million barrels of products and 545 million barrels of crude.

Two million barrels were to be released daily by the IEA.⁴ Nearly all 30 million barrels of products have been released, gasoline and heating oil imports are still in transit and continue to reach United States.⁵ They are reflected in the gasoline import statistics reported each Wednesday by EIA. Citing falling U.S. product demand, IEA Executive Director Claude Mandil told *Platts*:

There is no immediate issue right now, but there is still a lot of oil and products that will be missing in the balance. We still need to carefully monitor the situation together with our American friends to see whether demand destruction is long-lasting or not because there may be risks to supply in November and December.

³ DOE, Office Of Electricity Delivery and Energy Reliability, *Gulf Coast Hurricanes Situation Report #19*, Oct. 21, 2005

⁴ Of that total, 30 million barrels was to be crude oil from the U.S. Strategic Petroleum Reserve. On Sept. 14, DOE accepted bids on purchase of only 11 million barrels of the 30 million barrels that had been offered.

⁵ *Platts Oilgram Price Report, IEA Sees No Need For Additional Emergency Oil*, Oct. 7, 2005.

The most recent import statistics for the four weeks ending October 14⁶ show that refined product imports were about 1.4 mbd higher than year-to-date 2005, suggesting a continued flow of this fuel. As the IEA's Mandil points out, it remains to be seen how U.S. gasoline and distillate stocks hold up as the oil industry recovers from the hurricane damage.

Loans of crude oil from the Strategic Petroleum Reserve were granted to seven companies totaling roughly 13.2 million barrels.⁷ On September 2, as part of the 60 million barrel crude and product stock drawdown coordinated by the International Energy Agency (IEA), the United States offered 30 million barrels of SPR crude for sale. On September 14, DOE announced the sale of 10.8 million barrels of sweet crude and 200,000 barrels of sour at prices ranging from \$59.76 to \$66.46. Bids for an additional 8.2 million barrels were rejected. Additionally, some of the companies awarded loans may not borrow the full volume of crude for which they asked.

The results of crude oil and refined product offerings from government strategic reserves show demand for products to be stronger than crude, perhaps as a result of so much refining capacity shut by the hurricanes, and U.S. product demand exceeding the nation's refinery capacity during periods of normal supply and demand.

Petroleum Inventories and Prices

Despite a list of impediments to adding to crude and refined petroleum inventories, stocks of crude oil and refined products have not dropped to levels which could cause alarm. **Table 1** shows the changes in stocks for total petroleum, crude oil, gasoline, and distillate fuel oil between the week before Katrina struck (August 26) and the most recent week of October 14.

Table 1. U.S. Commercial Petroleum Stocks After Katrina
(million barrels)

	August 26	October 14	Change
Total Petroleum	1,024.5	1,004.3	-20.2
Crude Oil	321.4	312.0	-9.4
Gasoline	194.4	195.7	+1.3
Distillate Fuel Oil	135.2	122.7	-12.5

Source: EIA *Weekly Petroleum Status Report*, Table 3.

⁶ DOE/EIA, *Weekly Petroleum Status Report*, Oct. 20, 2005, Table 1.

⁷ Department of Energy. Office of Fossil Energy. See [http://www.fe.doe.gov/news/techlines/2005/tl_sprexchange_totalpetro.htm].

Table 1 shows that the major categories of petroleum inventories have experienced declines since Katrina, with the exception of gasoline. Total stocks have declined at a rate of about 750,000 bd. How these figures might be interpreted is a matter of some debate — the obvious facts are that they have declined, and that there is some level below which spot shortages and distributional problems begin to appear. Prior to March 2003, DOE’s Weekly Petroleum Status Report referred to this as the “minimum operational inventory” (MOI). Subsequent issues have dropped any reference to MOI because of differing views within the industry regarding what the minimum level might be. Because of improvements and inventory management and logistics, industry had recommended using lower figures than DOE had previously been using.

A DOE-industry dialogue held by the National Petroleum Council in August 2004 failed to reach an agreement on MOI, and it has not been referenced since it was dropped. When last shown on DOE’s charts of inventory levels,⁸ these statistics were 185 million barrels for gasoline and 85 million barrels for distillates (which includes both heating oil and diesel fuel). If these levels are a guide, there is about one day’s worth of gasoline stocks available (10.7 million barrels of “extra” stocks compared to about 8.8 mbd of demand) before run-outs would start to occur.

A tight inventory situation might be expected to be cause for concern; however, prices — for the moment at least — are falling. At the pump, regular gasoline prices peaked at \$3.06 (an all-time high) on September 5; they have steadily declined, falling to \$2.70 in mid-October. Wholesale prices and gasoline traded on the New York Mercantile Exchange (NYMEX) fell similarly.

The market does not appear to be responding to any shortage-related fears, but it may be responding to concerns about “demand destruction” resulting from high prices. Indeed, the data for the four weeks ending October 14 show demand for gasoline and middle distillates each about 200,000 bd below the year-ago period⁹

Distillate stocks are 37.7 million barrels above the old MOI level; demand is about 4.0 mbd, implying less than 10 days worth of supply cover. Wholesale trading on the NYMEX has seen distillates decline from \$2.13 per gallon at the end of September, to \$1.85 in mid-October, suggesting few current concerns — other than the level for retail prices — for the approaching heating season. EIA’s *Heating Oil and Propane Update* for October 10 shows a residential heating oil price of \$2.65 per gallon, down 4.4 cents from the prior week.

DOE has forecast that home heating costs will be much higher this winter than last. EIA Administrator Caruso indicated heating oil was forecast to cost \$2.54 per gallon, an increase from the 2004-05 heating season average price of \$1.92. He added that it could range as low as \$2.34 per gallon if the weather is warmer than normal, or as high as \$2.80 in a colder winter.

⁸ DOE/EIA, *Weekly Petroleum Status Report*, Feb. 21, 2003. See Figures 2, 3, and 4.

⁹ DOE/EIA, *Weekly Petroleum Status Report*, Oct. 14, 2005, Table 1.

On October 12, the EIA lowered its estimates of fourth-quarter 2005 demand for the United States by 900,000 bd — from 21.3 mbd to 20.4 mbd. Reductions included 160,000 bd in gasoline, 170,000 bd in distillates, and 430,000 bd of intermediate products, petrochemical feed stocks, and lubricants.¹⁰ It remains to be seen how this demand scenario plays out against fuel supply as refineries recover from the hurricanes, and if there are additional sales from IEA strategic stocks.

Relaxation of Motor Fuel Standards¹¹

On August 31, 2005, Environmental Protection Agency (EPA) Administrator Stephen Johnson announced that EPA would temporarily waive certain gasoline and diesel fuel standards nationwide through September 15, 2005, in order to help increase available fuel supplies. For gasoline, EPA waived volatility standards that would have otherwise prohibited the sale of gasoline produced for northern states in the South, or the sale of “winter” gasoline in the summer months. This waiver was intended to make it possible for gasoline normally prohibited in certain areas to be transported to those areas in response to supply limitations.

After September 15, many of the waived standards no longer applied, as the country transitioned from “summer” to “winter” gasoline.¹² EPA also waived national sulfur standards for diesel fuel, so that through September 15, fuel produced for non-road uses could be legally used in highway vehicles. This waiver was intended to help mitigate some of the disruption in diesel fuel supplies.¹³

In several cases, EPA has also issued waivers of specific standards for certain states or regions. These waivers have been issued on a case-by-case basis, as some standards and specific fuel supply issues vary from state to state, and within states. In most cases, these waivers will expire by the end of October.¹⁴

Natural Gas Disruption

In addition to crude oil, about 10 billion cubic feet per day (bcfpd) of natural gas — the equivalent of roughly 17% of total U.S. consumption — is produced from the federal offshore Gulf of Mexico. Cumulatively, since Katrina, a total of 278 bcf of

¹⁰ Platts Oilgram News, *EIA Sees Big Drop In US Demand in 4Q*, Oct. 13, 2005.

¹¹ Prepared by Brent Yacobucci.

¹² Ozone formation is more of a concern in warmer months, so gasoline standards are more stringent during the summer gasoline season (May through Sept. 15) than in the winter gasoline season (Sept. through May).

¹³ Remarks by Administrator Stephen L. Johnson, United States Environmental Protection Agency, Aug. 31, 2005, [<http://www.epa.gov/katrina/activities.html>].

¹⁴ The most recent information on these state and regional waivers is available from the EPA website at [<http://www.epa.gov/compliance/katrina/waiver/index.html>].

production has been shut in. As of October 12, 5.2 bcfpd (or 52%) of output was shut in. In effect, this amount reduced the nation's total current gas supply by about 10%.

Natural gas production from Louisiana state lands was also interrupted by the hurricanes. The Louisiana Department of Natural Resources estimated that 0.7 bcfpd of gas production has been restored, which is the equivalent of 31% of the 2.2 bcfpd state total.¹⁵ About 1.5 bcfpd remains offline in the 38 parish coastal region surveyed.

Combining lost gas output from state and federal lands, the total amount of 6.7 bcfpd is the equivalent of 11% of an average day's total consumption for the whole country.

Natural Gas Pipelines and Processing Facilities

Gas production can recover only as fast as transport facilities return to service. There is no comprehensive overview of the condition of pipeline and processing infrastructure in the storm-damaged region; repairs could prove a lengthy bottleneck in re-attaining pre-Katrina levels of gas flow.

One industry analyst noted:

While most pipeline companies have been eerily quiet about the status of pipelines, major facilities are still offline with little guidance as to when they will return to full strength.¹⁶

On October 13, DOE's Office of Electricity Delivery and Energy Reliability noted that 15 gas processing plants with aggregate capacity of 9.5 billion cubic feet or greater were offline in Louisiana. These plants had a pre-Katrina throughput of 5.3 bcfpd. Gas processing plants treat gas, upgrading it to "pipeline quality" and making it physically suitable for transport.

Both DOE and the Louisiana Department of Natural Resources publish updates of pipeline and infrastructure service status, but they do not paint a comprehensive picture of how gas is flowing over the long-distance grid and how much capacity remains sidelined. The case of Henry Hub is a good example. Henry Hub is a nodal point on the Sabine Pipeline, which connects with nine interstate and four intrastate pipelines. When fully operational, it has the capacity to move 1.8 bcfpd. Because of these attributes, it is the point at which NYMEX contracts for physical delivery are settled. Trading in Henry Hub futures is an extremely important benchmark for establishing natural gas prices nationwide.

The Sabine Pipeline went out of service after Rita, and force majeure was ultimately declared on the NYMEX contracts, resulting in postponement of trades and physical deliveries. Trading was suspended on September 22; it resumed on

¹⁵ Louisiana Department of Natural Resources, *Louisiana In-State Daily Production and Pipeline Update*, Oct. 12, 2005.

¹⁶ *Gulf Repair Job Tougher Than Expected*, by Christopher Edmonds. Thestreet.com, Oct. 12, 2002.

October 7, when Sabine partially reopened. How much gas can be transported given limited availability of pipeline compression is unclear, as is how this limited pumping ability might affect trading in futures and physical deliveries for traditional customers of deferred gas. The absence of definitive reports on the condition of the gas delivery infrastructure has caused uncertainty that has become reflected in spot gas prices.

Natural Gas Prices and Inventories

For the first months of 2005, wellhead prices for natural gas¹⁷ averaged just over \$6.00 per million Btu's. In July, they began to rise, averaging \$6.69 for that month and to \$7.48 in August. With the impact of both storms felt in natural gas markets during September, prices rose to an average of \$9.50. Trading on the NYMEX for Henry Hub has averaged between \$13 and \$14 per million Btu's.

While it may be early to make estimates of what natural gas prices could be this winter, producer gas prices have more than doubled since the first half of 2005. EIA recently forecast that wellhead prices will average \$11.40 this heating season if the weather is normal; they will run \$13.20 if the winter is 10% colder than normal and \$10.00 if the weather is 10% warmer than normal.¹⁸

In addition to the producer price of natural gas, residential consumers' rates also include long-distance pipeline tariffs and charges of a local distribution utility, which actually owns the connection to the home. Delivered residential natural gas cost \$11.13 per million Btu's during the winter of 2004-2005; this winter, EIA projects a range of \$15.32 to \$16.68, and \$15.58 with normal cold weather. A normal winter would see prices about 48% above last winter.

Natural gas demand tends to be highest during the winter months, and gas produced in non-peak demand months is stored to meet peak demand. Storage peaks at about 3.25 trillion cubic feet (tcf) in late fall, and declines to about 0.75 tcf at the end of the heating season, typically during April.¹⁹ Current inventory is about 3.0 tcf — about the average stock level during the past five years.

During the most recent week, 75 bcf were added to storage (slightly under the five-year average figure for this week), suggesting that gas is available and flowing in the nation's pipeline system. To what extent this will be the case after the onset of cold weather remains to be seen, but it is likely that prices will keep demand in check, and allocate supply where needed.

¹⁷ EIA, *Natural Gas Weekly Update*.

¹⁸ EIA's *Winter Fuel Outlook*, a presentation by Administrator Guy Caruso, Oct. 12, 2005.

¹⁹ See EIA's *Weekly Natural Gas Storage Report*.

Electric Power ²⁰

At the end of September, more than 340,000 customers remained without power in Louisiana — more than 190,000 from Hurricane Katrina, and an additional 149,000 from Hurricane Rita. In Texas, 316,000 remained without electricity.

October saw great progress in restoring electricity to customers whose premises were able to accept power. At the middle of the month, only 12,500 customers were without power in Texas; 129,300 did not have electric service in Louisiana.

²⁰ DOE, Office of Electricity Delivery and Energy Reliability, *Hurricane Situation Report #17*.