

IMPACTS OF '05 HURRICANES ON LOUISIANA'S ENERGY INDUSTRY

by

Bryan Crouch, Engineer
Manuel Lam, Senior Analyst
Patty Nussbaum, Engineer

The 2005 Atlantic hurricane season was the most active on record, shattering many long standing records. A total of 27 named storms during the season surpassed the old record of 21 set in 1933. Fifteen of those storms produced hurricanes and broke 1969's record high of twelve. Three of the hurricanes, Katrina, Rita, and Wilma, reached Category 5 strength. The 107 billion plus dollars in damage costs that resulted from four major hurricanes making landfall in the U.S. was also a record breaker. Louisiana's coast was impacted by Hurricanes Cindy, Katrina and Rita.

Tropical Storm Cindy formed July 3, 2005 in the extreme western Caribbean Sea, then moved northward. July 6, Cindy made landfall as a Category 1 hurricane over the southwest portion of Grand Isle, Louisiana. Cindy produced locally heavy rainfall and wind, and downed tree limbs which created extensive power outages, but caused minimal damage.

Hurricane Katrina first struck southern Florida August 25, 2005 as a Category 1 hurricane. After passing over Florida, it moved into the Gulf of Mexico where it quickly re-intensified over the warm Gulf water. Its maximum wind speed reached 175 mph (Category 5) and the minimum central pressure dropped as low as 902 millibars (a measure of a hurricane's strength). Katrina's intensity dropped slightly to a Category 4 as it approached the central Gulf Coast. August 29, Katrina made landfall along the Louisiana and Mississippi coasts as a strong Category 3 hurricane. Hurricane force winds, covering 120 miles from its center, caused widespread destruction. The associated storm surge reached as far east as Mobile, AL. A 20 - 30 ft. plus storm surge swept across Biloxi and Gulfport, Mississippi, and Plaquemines and St. Bernard Parishes in Louisiana reaching far inland and decimating everything in its path. A combination of strong winds, heavy rainfall and storm surge caused breaks in the eastern levee system which separates New Orleans from surrounding lakes and canals leaving 80% of New Orleans flooded; some areas had 20 ft. of water at some point in the flooding.

A few weeks after Katrina's devastation in southeast Louisiana, Hurricane Rita entered the Gulf of Mexico. Its steady wind speed peaked at 175 mph. Hurricane Rita is on record as the strongest measured hurricane to ever have entered the Gulf of Mexico and the fourth most intense hurricane ever in the Atlantic Basin. Rita first struck Florida after making an approach near Cuba and went on to make landfall between Sabine Pass, TX and Johnson's Bayou, Louisiana on September 24, 2005 as a Category 3 hurricane with wind speeds of 120 mph and a storm surge of 10 ft. A day prior to landfall, Rita caused a storm surge on Louisiana's coast which reopened some of the levee breaches caused by Hurricane Katrina a month earlier and re-flooded parts of New Orleans. Post-landfall damage was extensive in the coastal areas in southwestern Louisiana and extreme southeastern Texas.

Hurricane Katrina was not the strongest hurricane to ever strike the U.S., but it was the most destructive and most costly U.S. hurricane on record. Katrina's strength was lower than Camille's which destroyed Mississippi's coast in August 1969, but with hurricane force winds emanating 120 miles from its center it caused more widespread destruction and will likely cost more than 80 billion dollars.

Hurricanes in the Gulf of Mexico have always impacted Louisiana's energy industry, but never to the degree that the hurricanes of 2005 did, particularly Hurricanes Katrina and Rita. Three main areas affected were oil and gas production and transportation, refineries, and electricity generation and transmission. The impacts to each are discussed below.

Oil and Gas Production and Transportation

The Gulf of Mexico is a major center for crude oil and gas production in the U.S. It produces 29% of the U.S. domestic oil production and 20% of the natural gas production. The effect of any tropical storm or hurricane that enters the Gulf of Mexico is noticeable when it comes to oil and gas production. When tropical storms or hurricanes enter the Gulf's production areas there is a mandatory evacuation of production platforms which disrupts the business of supplying energy.

The 2002 hurricane season had two strong hurricanes that went through the Gulf oil and gas producing areas. The U.S. Department of the Interior's Minerals Management Service (MMS) reported the oil and gas cumulative shut-in production volume in the Gulf of Mexico due to Hurricanes Lili and Isidore was more than 14.4 million barrels (MMB) of oil and 88.9 billion cubic feet (BCF) of natural gas. Hurricane Lili forced the evacuation of 769 platforms and 100 active rigs in the Gulf of Mexico. Of the 800 facilities subjected to the full force of the hurricane, only six older platforms and four exploration rigs received substantial damage.

The 2003 hurricane season's damage was very light even though two hurricanes, Claudette and Erica, touched the Gulf's production areas. Both were Category 1 hurricanes which produced a lot of rain and disrupted production, but the offshore platforms, drilling rigs, pipelines and other structures sustained minimal damage.

In 2004, the Gulf of Mexico experienced two named tropical storms, Bonnie and Matthew, one Category 3 hurricane, Jeanne, two Category 4 hurricanes, Charles and Frances, and one Category 5 hurricane, Ivan. The 2004 hurricane season was the second most expensive ever for the Gulf of Mexico oil and gas industry. Hurricane Ivan left 140 BCF of gas (4.4% of annual production) and 35.34 MMB of oil (5.8% of annual production) cumulative production volume shut-in. MMS reported that Ivan forced the evacuation of 574 platforms and 69 rigs. Of the 4,000 platforms working in the Gulf, seven were destroyed and six sustained major damage. Six of 117 drilling rigs working in the Gulf sustained major damage. Hurricane Ivan caused major infrastructure damage. Ten thousand miles of pipeline were in the direct path of the hurricane. It was reported that some pipelines in the mouth of the Mississippi River were moved 3,000 feet while others were buried under 30 feet of mud. These pipelines took a significant effort to locate and repairs took seven months to accomplish. The Louisiana state regulated and the southern parishes' production losses from the hurricane and damages to the infrastructure are not available.

The 2005 hurricane season is the most expensive ever for the Gulf of Mexico oil and gas industry. Four hurricanes, Cindy, Dennis, Katrina and Rita, crossed the Gulf oil and gas producing areas.

MMS reported the damage caused by Hurricane Dennis to oil and gas operations in the Gulf of Mexico was extremely light. The eye of the hurricane was about 120 miles farther east than Hurricane Ivan's landing, and it was in the deeper water sections of the Gulf so the impact to the platforms and rigs was minimal. The path of the hurricane carried it mostly over open water with no oil and gas operations. Most

of the damage was small amounts of missing handrails and steel grating from the lower levels of the platforms. There was no reported damage to the transportation pipelines and a very small number of damage reports to infield flow lines. The cumulative oil shut-in production volume was 5.29 MMB, the equivalent of 0.968% of the yearly production of oil in the Gulf of Mexico, approximately 547.5 MMB. The cumulative gas shut-in production volume was 23.246 BCF, the equivalent of 0.637% of the yearly production of gas in the Gulf of Mexico, approximately 3.65 trillion cubic feet (TCF). Hurricane Dennis forced the evacuation of 359 of 819 manned platforms and 86 of the 134 active rigs in the Gulf. Hurricane Cindy had little impact.

Hurricane Katrina forced the evacuation of 482 of 819 manned platforms and 79 of the 137 active rigs in the Gulf. MMS reported that hurricane Katrina reduced Gulf of Mexico oil by over 1.37 MMB per day or 90.43% of daily Gulf of Mexico oil production and that gas production was reduced 7.866 BCF per day or 78.66% of daily Gulf of Mexico natural gas production. Before other statistics could be compiled, Hurricane Rita appeared and added more damage to the oil and gas production infrastructure. Louisiana onshore and state offshore had 1,401 wells shut-in in the 38 southern parishes region. Cumulative production losses for the storms in these areas is not known. There are roughly 4,000 Outer Continental Shelf (OCS) production facilities; Hurricane Katrina destroyed 46 platforms and 4 rigs, and damaged 20 platforms and 9 rigs. Hurricane Rita destroyed 63 platforms and 1 rig and damaged 30 platforms and 10 rigs. Most of the destroyed platforms were in shallow water. Four large, deep water platforms suffered extensive damage and could take 3-6 months to bring back on line. Nineteen rigs were set adrift.

As of February 22, 2006, the cumulative oil shut-in production volume was 129.59 billion barrels (23.67% of the yearly production in the Gulf of Mexico) and the cumulative shut-in gas production volume was 652.63 BCF (17.88% of the yearly production in the Gulf of Mexico). There is still 363 thousand barrels per day and 1.50 billion cubic feet per day shut-in.

More than 10 percent of the nation's imported crude oil typically enters at the Louisiana Offshore Oil Port (LOOP). Currently, LOOP is providing crude oil for the Capline pipeline which delivers to many refineries in the Midwest. Typically about 1 MMB per day go through LOOP. August 28, 2005 LOOP stopped all operations in order to give employees time to evacuate from Hurricane Katrina. According to a LOOP port official, the facility suffered "no apparent catastrophic damage." The biggest hurdle the LOOP facility had in restarting operations was getting power restored. LOOP resumed operation September 2 and was running at full capacity by September 11th.

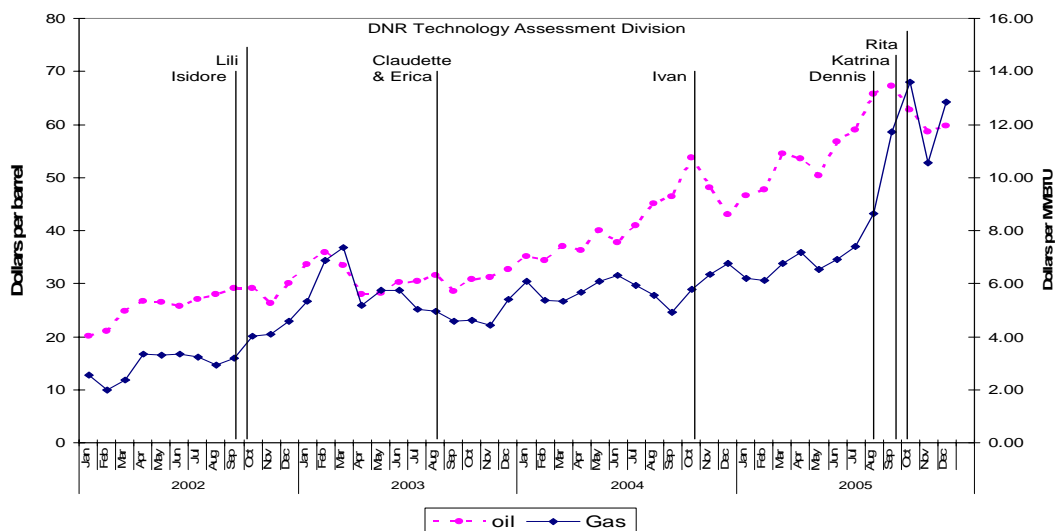
Damage to pipelines that transport crude oil, oil products and natural gas was minimal. Most of the pipelines were taken out of service due to personnel evacuations and safety precautions and were restored to full operation as soon as electrical service was restored. The exception was the Sabine Pipeline, operator of the Henry Hub. The Sabine pipeline sustained wind damage in the vicinity of the Port Neches compressor station and water damage at the Henry Hub facilities. There was also no electric service in most areas of the system and the Sabine Pipeline was out of service for several weeks.

Hurricane Katrina, apparently, had little impact on receipts of liquefied natural gas (LNG) shipments at the Southern Union's Trunkline LNG terminal in Lake Charles, Louisiana. As Hurricane Rita approached, Exceleerate Energy's Gulf Gateway Energy Bridge offshore Louisiana LNG facility and Southern Union's Trunkline onshore facility were off line due to evacuations, lack of supplies, an inability to move stored liquids, and safety precautions. The facilities' infrastructure are intact and expected to be fully operational

as soon as supplies and shipping pipelines are available. After the hurricanes passed, the following gasplants closed due to flooding, lack of supplies, an inability to move stored liquids, or as a safety precaution (the parish of each location is in parentheses): Barracuda (Cameron), Bluewater (Acadia), Burns Point (St. Mary), Cameron (Cameron), Gillis (Calcasieu), Lake Charles (Calcasieu), Lowry (Cameron), Paradis (St. Charles), Tebone (Ascension), Sabine Pass (Cameron), St. Landry (Evangeline), Stingray (Cameron), Venice (Plaquemine), and Yscloskey (St. Bernard). The processing plants known to be not operating have a combined capacity of more than 10 BCF per day, however, this number does not reflect actual flows before Hurricanes Katrina and Rita. In December, Duke Energy Field Services (DEFS) noted that refineries and fractionators along the Gulf Coast affected by the hurricane are discontinuing their operations, resulting in a lack of natural gas liquids take-away capacity. The loss has delayed, and will continue to delay, the recovery of natural gas production in the area. Even if platforms and pipelines are either unaffected or readily restored to service, the gas often can not flow to market without treatment. In 2003 (the latest year with complete data), almost three-fourths of total U.S. marketed gas production was processed prior to delivery to market. On December 27, 2005, EIA reported that most of the inactive plants are expected to be operating by January 2006.

Figure 1 shows the effects that the 2005 hurricanes, as well as several previous hurricanes, have had on oil and gas prices.

Figure 1. Louisiana Oil and Gas Spot Prices, 2002 – 2005



Refineries

Two characteristics of the U.S. refining industry were highlighted when Hurricanes Katrina and Rita struck; the concentration of refineries along the Gulf Coast, and the low surplus refining capacity.

Operable refinery utilization rates increased dramatically from the early 1980s to the late 1990s and have remained high since then. High operable utilization rates translate into low spare capacity which reduces the industry's ability to maintain adequate fuel supplies should a loss of capacity occur. Basic economics teaches us that when supply decreases relative to demand, prices increase. That was precisely the scenario that played out in the summer of 2005 when Hurricanes Katrina and Rita blew ashore into areas of Louisiana and Texas that are home to 38% of the U.S. refinery capacity.

Prior to Hurricanes Katrina and Rita, the U.S. refinery operable capacity was 17,124,870 million barrels per calendar day (bcd) (with an operating utilization rate of 93.2%), and idle capacity stood at 118,580 bcd. The combined refinery capacity that was in the paths of hurricane Katrina and Rita totaled approximately 6.5 MMB per day, or 38% of the total U.S. refining capacity.

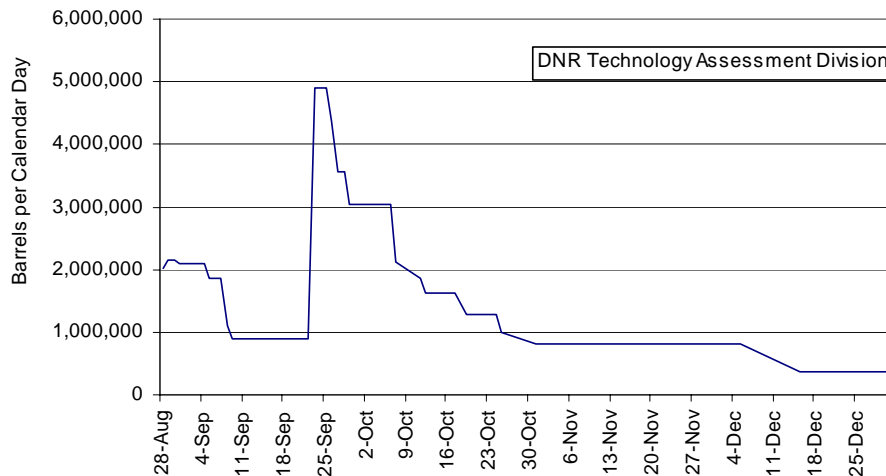
On August 28, in preparation for the storm, approximately 2.1 million bcd (325,000 bcd from one refinery in Mississippi and the rest from ten refineries in Louisiana) went off line. After Katrina blew through and power began to be restored, refineries that sustained minor or no damage began to come back online. Then, on September 24, with 879,000 bcd of refinery capacity in Louisiana and Mississippi still shut down due to Hurricane Katrina, Hurricane Rita came ashore and reduced refinery capacity by an additional 4 million bcd (594,000 bcd from three Louisiana refineries and 3.4 million bcd from thirteen Texas refineries). Table 1 lists the 13 Louisiana refineries affected by Hurricanes Katrina and Rita.

Table 1. Louisiana Refineries Affected by '05 Hurricanes

Hurricane	Refinery	Location	Capacity (bcd)	(Note)
Katrina	ConocoPhillips	Belle Chase	247,000	(major damage)
	Chalmette Refining	Chalmette	187,200	(major damage)
	ExxonMobil	Baton Rouge	493,500	
	Marathon Petroleum	Garyville	245,000	
	Murphy Oil	Meraux	120,000	(major damage, still shutdown)
	Motiva	Convent	235,000	
	Motiva	Norco	226,500	
	Placid	Port Allen	48,500	
	Valero	Krotz Springs	80,000	
	Valero	Norco	185,000	
Rita	Citgo	Lake Charles	324,300	
	ConocoPhillips	West Lake	239,400	
	Calcasieu	Lake Charles	30,000	

In the wake of the storms, several refineries sustained significant damage. Three refineries in Louisiana (see Table 1) and Chevron’s Pascagoula refinery sustained major damage. All of the affected refineries are currently back on-line and operating at or near full capacity, except Murphy Oil in Meraux which expects to return to operation by April. Figure 2 shows shut down refinery capacity versus time.

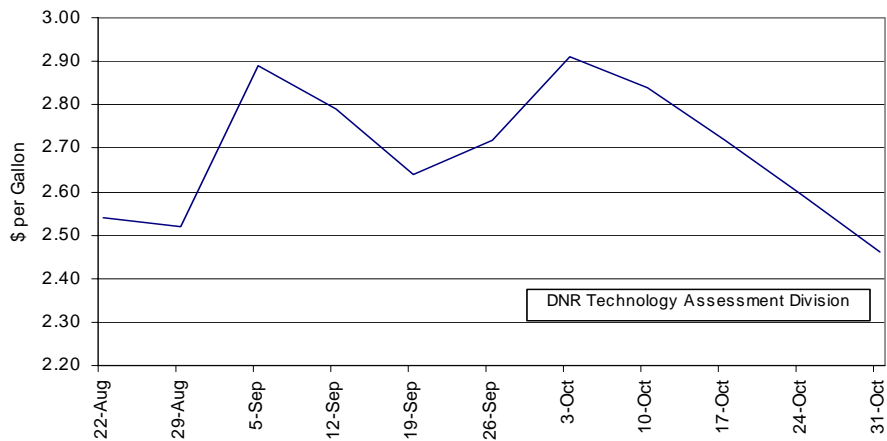
Figure 2. Shut Down Refinery Capacity from Hurricanes Katrina and Rita



In addition to the capacity reductions shown in the chart on the preceding page, several refineries that were not directly affected by the hurricanes had to reduce output due to a shortage of crude oil that resulted from wells being shut in and pipelines being without electricity.

As expected, the sudden reduction in refinery capacity resulted in fuel shortages and price spikes. Gasoline prices increased nearly \$0.40 per gallon, but were back down to pre-hurricane levels by mid-October (see Figure 3). Diesel prices experienced a similar jump.

Figure 3. Gulf Coast Regular Gasoline Prices



Electricity Generation and Transmission

Hurricane Katrina was an unprecedented event for electricity in Louisiana. Katrina was a large storm which impacted many utilities and caused major damage to property. Both the generating plants and the transmission infrastructure were affected. In addition, the flooding that accompanied the storm further worsened conditions by impeding access needed for recovery and restoration and damaging equipment that was sitting in the water. Difficulty in getting gasoline, as well as the logistics of feeding and housing restoration crews in areas that were evacuated, compounded the problems.

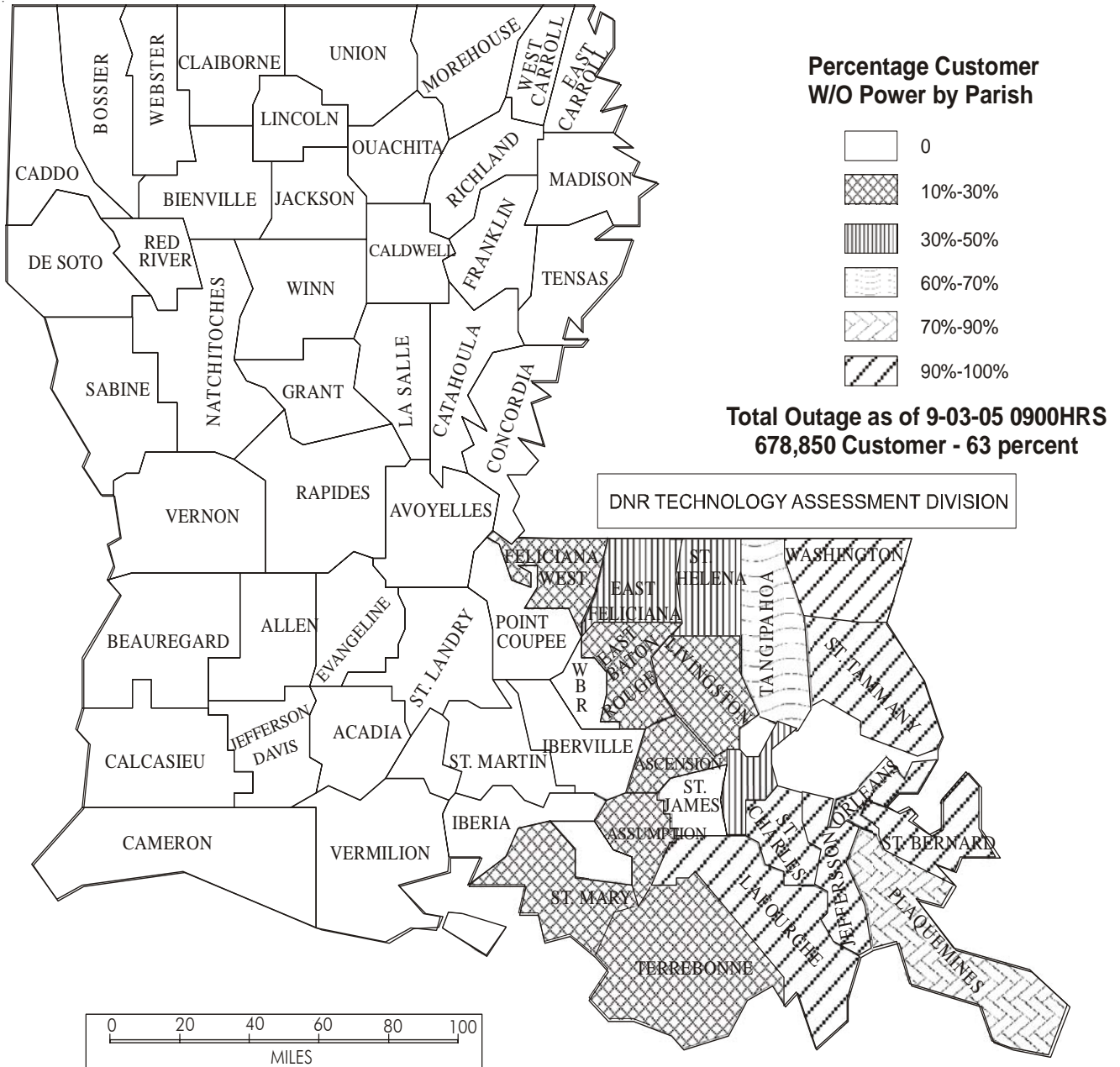
According to the situation reports from the Office of Electricity Delivery and Energy Reliability U.S. Department of Energy (August 29, 2005 (10:00 PM EDT)) Louisiana had 966,085 or 42% of customers without power. Table 2 lists the utilities included in the report.

Table 2. Customers Without Power

Company	No. of Customers without Power
Entergy Louisiana	409,399
Entergy Gulf States	166,000
Cleco	71,399
Entergy New Orleans	215,163
Dixie Electric Membership Corp.	69,050
Washington-St. Tammany E C	20,000
South Louisiana Electric Coop Association	13,874
City of Morgan City	1,200

Figure 4 shows by parish the percentage of customers without power as of September 3, 2005.

Figure 4. Hurricane Katrina Electricity Outage



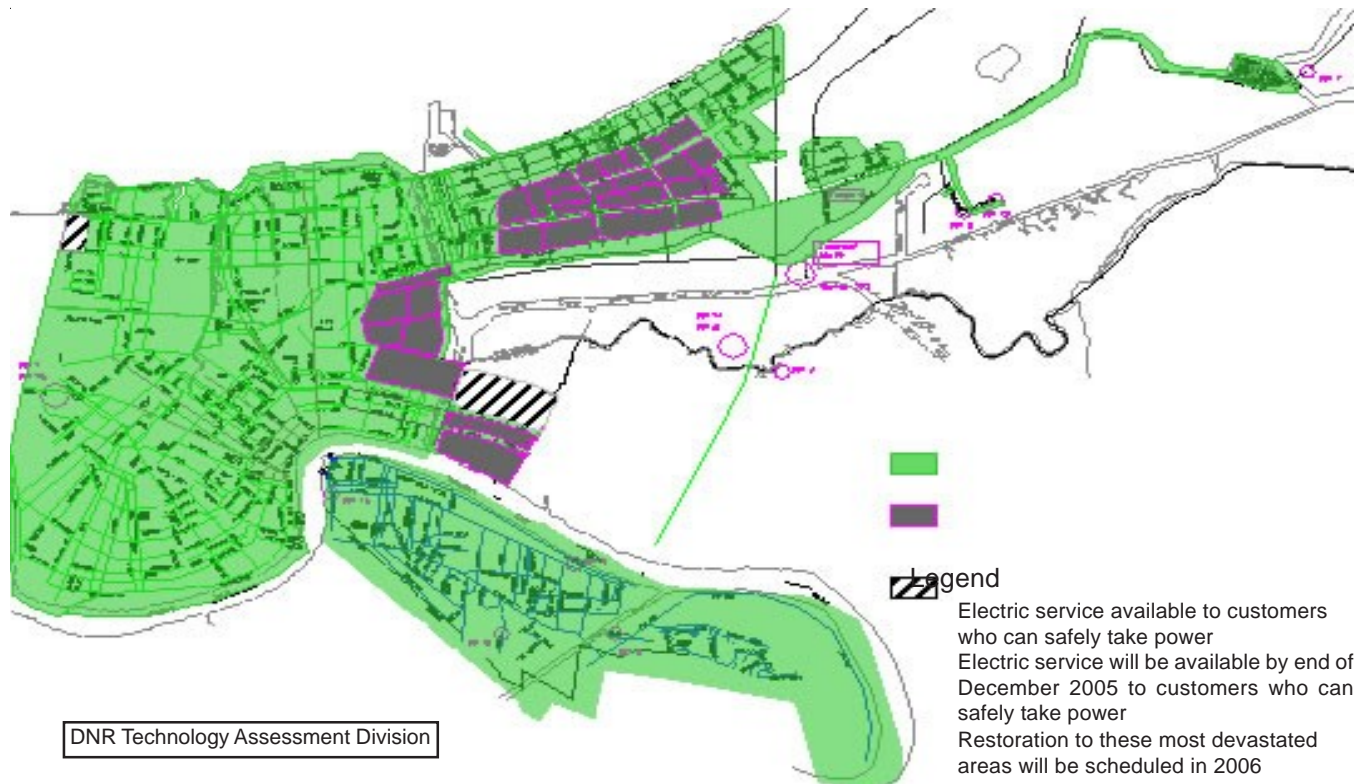
Source: Louisiana Public Service Commission

Entergy Transmission reported 181 lines and 263 substations out of service following Katrina's hit. More than 1.1 million Entergy customers lost power in Louisiana and Mississippi. The outage total more than quadrupled the previous Entergy record of 270,000 set by Hurricane Cindy. Then 26 days later, with restoration still underway from Katrina, Hurricane Rita knocked out 800,000 Entergy customers and damaged transmission lines from Lafayette to Conroe, Texas. Some portions of the Entergy system had to be restored more than once.

Power has been restored to all customers capable of receiving it except the 123,000 houses and businesses in and around New Orleans that need to be rebuilt (Figure 5). At this time, no one knows when, or even if, the population will return to all of these areas. Entergy New Orleans (ENO), the utility that provides electric and natural gas service to the City of New Orleans, now becomes the focus. The company noted in the situation reports from the Office of Electricity Delivery and Energy Reliability U.S. Department of Energy (December 5, 2005, 3:00 PM EST) that “Hurricane Katrina not only caused catastrophic and unprecedented damage to ENO’s electric and gas facilities, but also resulted in the loss of most of ENO’s customers, an unprecedented occurrence in the U.S. Utility Industry.”

Entergy New Orleans filed for bankruptcy protection under Chapter 11 of the U.S. Bankruptcy code on September 23, 2005. Entergy and the City of New Orleans are requesting federal aid for the bankrupt New Orleans utility. Usually utility customers pay the costs of storm restoration. They fear that, without federal aid, increased utility costs in New Orleans will slow down the city’s recovery.

Figure 5. New Orleans Area Electricity Restoration



Source: http://www.entergy-neworleans.com/content/your_home/storm_center/ENOI_Electric_map.ppt