Understanding the Impacts of Katrina and Rita on Gulf Coast Energy Infrastructure

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Summary on Impacts of Hurricanes

- Hurricanes were incredibly destructive to energy business – effects felt for some time. Was a shining moment for all in the industry.

- Hurricanes clearly showed the interrelationship of all types of energy infrastructure in the Gulf – the “4 Ps” – production, processing, pipes, and power.

- Hurricanes impacts were felt nationally and internationally – drives home importance of Gulf coast and critical energy infrastructure.
Platforms/Structures Impacted by 2005 Hurricanes

Legend
GOM Platforms
Age in Years (2005)
- 0-20
- 20-40
- 40+
- Katrina’s Path
- Rita’s path

Platform Age Groups

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As of June 2006, there was 936 MMcf/d and 179 MBBL/d of shut in gas and oil production.

Total Oil Losses: 165 MMBbls
Total Gas Losses: 800 Bcf

Note: Shut-in statistics for Ivan were no longer reported after 150 days. The last shut-in statistics for Katrina and Rita were published on June 21, 2006 (the 296th day after Katrina made landfall). Total pre-hurricane crude production of 1.5 MMBBls/d and gas of 10 Bcf/d.

**Total Immediate Refinery Impact**

**Hurricane Katrina**

- LA/MS/AL Gulf Coast Refiners (reduced runs and shutdowns)
  - 2,528 mbbl/day
  - 15% of US operating capacity
- Port Arthur/Lake Charles (reduced runs and supply loss)
  - 775 mbbl/day
  - 5% of US operating capacity
- Midwest (reduced runs – supplied by Capline Pipeline)
  - 1,628 mbbl/day
  - 10% of US operating capacity
- Remaining US Operating Capacity
  - 12,075 mbbl/day
  - 70% of US operating capacity

**Total Refinery Impact**
- 4,931 mbbl/day
- 30% of US operating capacity

**Source:** Energy Information Administration, Department of Energy

**Hurricane Rita**

- Port Arthur/Lake Charles (shutdowns and damaged facilities)
  - 1,715 mbbl/day
  - 10% of US operating capacity
- Houston/Texas City (shutdowns and damaged facilities)
  - 2,292 mbbl/day
  - 13.5% of US operating capacity
- Corpus Christi (shutdown and reduced runs)
  - 706 mbbl/day
  - 4% of US operating capacity
- Midwest (reduced runs from supply loss)
  - 338 mbbl/day
  - 2% of US operating capacity
- Remaining US Operating Capacity
  - 11,954 mbbl/day
  - 70% of US operating capacity

**Total Refinery Impact**
- 5,052 mbbl/day
- 30% of US operating capacity

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Gasoline Price Increases
August 30, 2005 to September 6, 2005

Regional Changes in Gasoline Prices (cents per gallon)

Source: American Petroleum Institute
Outages at gas processing facilities throughout all of south Louisiana was one of the more unique aspects of the combined hurricanes.

<table>
<thead>
<tr>
<th>State/Company</th>
<th>Facility</th>
<th>Gas Capacity (MMcf/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duke Energy Field Services</td>
<td>Mobile Bay</td>
<td>600.0</td>
</tr>
<tr>
<td>Shell Western E P Inc</td>
<td>Yellowhammer</td>
<td>200.0</td>
</tr>
<tr>
<td>Louisiana</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Louisiana Plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venice Energy Services Co LLC</td>
<td>Venice</td>
<td>1,300.0</td>
</tr>
<tr>
<td>Enterprise Products Operating LP</td>
<td>Toca</td>
<td>1,100.0</td>
</tr>
<tr>
<td>Dynegy Midstream Services LP</td>
<td>Yscloskey</td>
<td>1,850.0</td>
</tr>
<tr>
<td>West Louisiana Plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynegy Midstream Services LP</td>
<td>Barracuda</td>
<td>225.0</td>
</tr>
<tr>
<td>Dynegy Midstream Services LP</td>
<td>Stingray</td>
<td>305.0</td>
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<tr>
<td>BP PLC</td>
<td>Grand Chenier</td>
<td>600.0</td>
</tr>
<tr>
<td>Williams Cos</td>
<td>Johnson Bayou</td>
<td>425.0</td>
</tr>
<tr>
<td>Gulf Terra Energy Partners LP</td>
<td>Sabine Pass</td>
<td>300.0</td>
</tr>
<tr>
<td>Central Louisiana Plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amerada Hess Corp</td>
<td>Sea Robin</td>
<td>900.0</td>
</tr>
<tr>
<td>Duke Energy Field Services</td>
<td>Patterson II Gas Plant</td>
<td>500.0</td>
</tr>
<tr>
<td>Dynegy Midstream Services LP</td>
<td>Lowry</td>
<td>300.0</td>
</tr>
<tr>
<td>Enterprise Products Operating LP</td>
<td>Calumet</td>
<td>1,600.0</td>
</tr>
<tr>
<td>Enterprise Products Operating LP</td>
<td>Neptune</td>
<td>650.0</td>
</tr>
<tr>
<td>Gulf Terra Energy Partners LP</td>
<td>Cow Island</td>
<td>500.0</td>
</tr>
<tr>
<td>Gulf Terra Energy Partners LP</td>
<td>Pelican</td>
<td>325.0</td>
</tr>
<tr>
<td>Marathon Oil Co</td>
<td>Burns Point</td>
<td>200.0</td>
</tr>
<tr>
<td>Norcen Explorer</td>
<td>Patterson</td>
<td>600.0</td>
</tr>
<tr>
<td>Mississippi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP PLC</td>
<td>Pascagoula</td>
<td>1,000.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>13,480.0</td>
</tr>
<tr>
<td>TOTAL GOM CAPACITY</td>
<td></td>
<td>20,285.0</td>
</tr>
<tr>
<td>PERCENT OF TOTAL GOM</td>
<td></td>
<td>66.5%</td>
</tr>
</tbody>
</table>

Source: Oil and Gas Journal; Energy Information Administration, Department of Energy
Damage to power infrastructure (transmission) extensive. Restoration was monumental and impressive, but still created “nervous” moments for other energy infrastructure.
Refining capacity restoration closely follows power system restoration, which in turn have direct impacts on refined product markets.

Source: Assumes 95 percent capacity factor; assumes 4 week recovery for facilities damaged by Rita.
Examples of Energy Infrastructure Damage
Shell Mars Tension Leg Platform

Source: Shell.com
Shell Mars Tension Leg Platform

Source: Shell.com
Semi-Sub Stuck Under Bridge
North Mobile Bay

Photo via Noble Drilling and GlobalSantaFe

Source: Rigzone.com
Venice Port, Supply & Crew Bases

Source: LIOGA
Air Products Facility – Normal Day
New Orleans, Louisiana (Intracoastal Drive)
Air Products Facility – During Hurricane Katrina
New Orleans, Louisiana

Source: Air Products

© LSU Center for Energy Studies
Air Products Facility – Post Hurricane Katrina
New Orleans, Louisiana

Source: Air Products
Power Outages
Generating Stations – Entergy Patterson

Source: Entergy
Power Outages
Substation Damage

Source: Entergy
Then,
Along Comes Rita
Citgo Refinery – Storage Tank
Lake Charles, Louisiana
Post-Rita

Source: Citgo
Citgo Refinery – Onsite Dock
Lake Charles, Louisiana
Post-Rita

Source: Citgo
Citgo Refinery – Cooling Tower
Lake Charles, Louisiana
Post-Rita

Source: Citgo
Facility rental of $3.5 million for 3 weeks – for 250 employees – roughly $156 per day per person
Temporary Natural Gas Release: To date, all re-opened safety valves have held. There have been a couple of incidents where pipeline damage has allowed the temporary venting of gas that was in the pipeline. There are currently no known incidents of gas venting from wells and the temporary venting from pipelines appears to have stopped.
Energy Capacity Offline:
Current and Forecast
Cumulative GOM crude oil production shut-ins equal to the processing capacity of one major U.S. refinery (419,000 Bbls/d)

<table>
<thead>
<tr>
<th>Year</th>
<th>Shut-in Oil Production</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>106.4 million barrels</td>
<td>69.5%</td>
</tr>
<tr>
<td>2006</td>
<td>46.7 million barrels</td>
<td>30.5%</td>
</tr>
<tr>
<td>Total</td>
<td>153.1 million barrels</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Note: Assuming recovery of 4.7 bcf per day after April 5, 2006.
Cumulative GOM natural gas production shut-ins equal to Florida’s total annual gas usage (704 Bcf).

Forecast versus New Forecast Natural Gas

<table>
<thead>
<tr>
<th>Shut-in Gas Production</th>
<th>bcf</th>
<th>percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>553.9</td>
<td>75.9%</td>
</tr>
<tr>
<td>2006</td>
<td>176.3</td>
<td>24.1%</td>
</tr>
<tr>
<td>Total</td>
<td>730.2</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Note: Assuming recovery of 32 bcf per day after April 5, 2006.
Estimated energy expenditures increased dramatically for industry and utility customers in aftermath of hurricanes due to limited local supplies.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Million $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock Increase</td>
<td>$ 53.1</td>
</tr>
<tr>
<td>Power Gen Increase</td>
<td>$ 398.7</td>
</tr>
<tr>
<td>Total Power and Industry</td>
<td>$ 580.0</td>
</tr>
</tbody>
</table>

Note: CES estimated energy expenditures based upon daily 2005 average usage. For illustrative purposes only since usage is unadjusted for hurricane-related interruptions.
Loss of 310 million barrels of productive capabilities (7 percent of total).

This is equivalent to shutting down all US refineries for over 18 days.

Source: Assumes 95 percent capacity factor
• GOM region has played an important historic role in the development of energy infrastructure. Not likely to change despite hurricane activity.

• Hurricanes proved that the region, its workforce, and the underlying assets are resilient and can be restored quickly, even in the face of two natural disasters.

• Some concerns about “diversifying” energy infrastructure in the region. Given current economic challenges concern is that diversity in some infrastructure areas could “diversify” to other parts of the world, which actually increase US vulnerability, not decrease it.

• Man-made incidents and catastrophic incidents should not be taken lightly -- but the “stochastic” nature of these events requires a more probabilistic approach to mitigation – more than likely a resiliency as opposed to “hardening” solution.
Questions, Comments, & Discussion

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