



OCS-Related Infrastructure in the GOM: Update and Summary of Impacts

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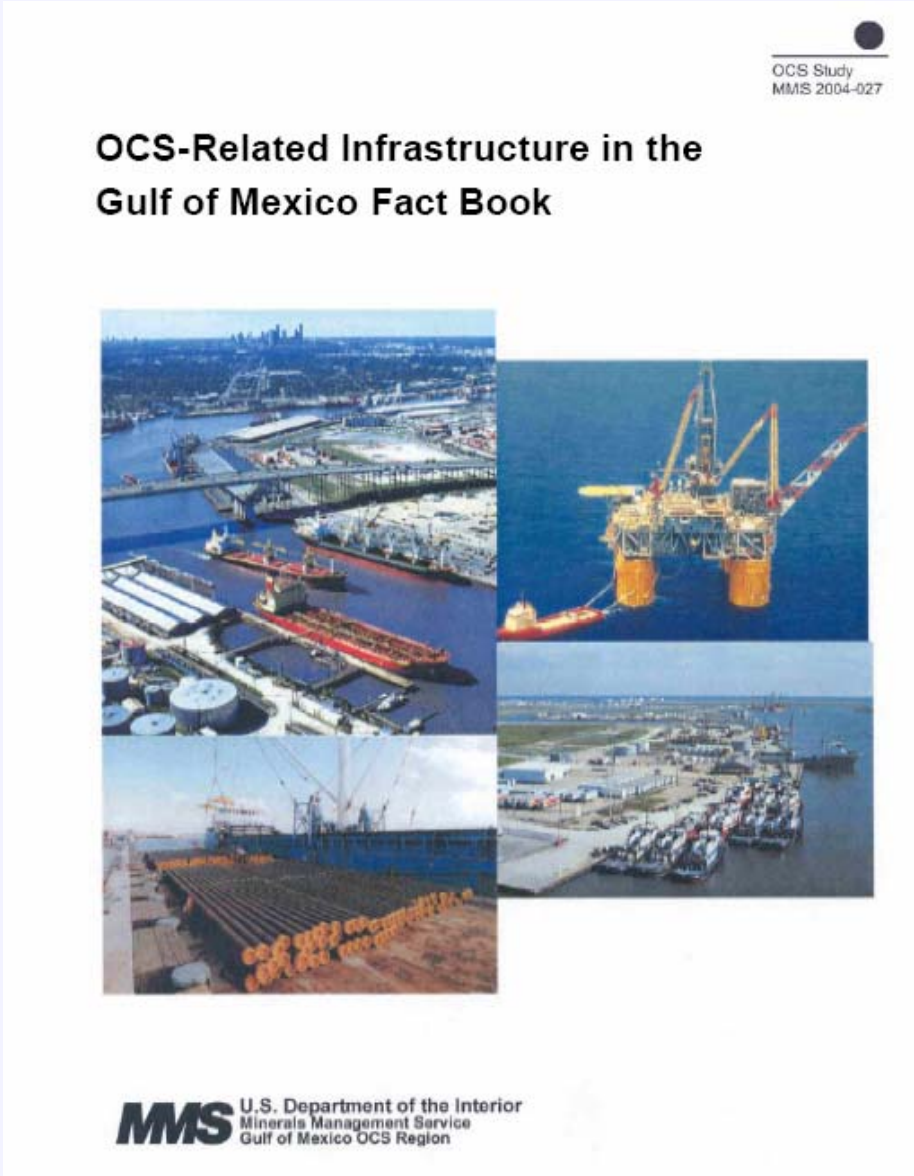
Infrastructure Fact Book Project: Original and Update



The goal of the original infrastructure factbook was to identify, categorize, and describe a broad range of infrastructure-supporting offshore activities. Additional emphasis discussed current challenges to infrastructure development, outlook, and impacts on these by OCS activities.

The follow-up project updates information in the original factbook and expands on this initial work by adding hurricane-related impacts.

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Is Energy Infrastructure Concentration an Asset or Liability?

- Concentration of infrastructure along the Gulf of Mexico (GOM) is an asset, not a liability.
- While many areas of the Gulf South will take years to be rehabilitated, the energy sector has been able to rebound in a matter of months from the most comprehensively destructive set of storms in its history.
- Despite concentration of assets, the overwhelming majority of all energy infrastructure was rehabilitated in less than 45 days after the events of 2005—there is probably no place in the world where that kind of restoration activity could have been done in that amount of time.
- Emphasis should be on developing policies that help insure infrastructure and quickly rehabilitate infrastructure in concentrated areas. “Bend don’t break”

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How Concentrated Is Activity in the GOM?

The Gulf of Mexico

- Supports 30% total domestic crude oil production and 20% total natural gas production
- Provides over $6 billion in federal royalties and fees
- Supports 45% of total U.S. refining capacity (62% east of the Rockies)
- Is home to the last greenfield refinery in U.S. (Garyville, LA, 1975)
- Supports 60% of total crude imports (LOOP supports 15% alone)
- Is home to 43 of the SPR storage capability
- Is responsible for a large share of the refining, pipeline and petrochemical industry in the U.S.
- Is the origination point for most of the pipeline capacity in U.S. (25,000 miles in Louisiana alone)
- Is home to the Henry Hub
- Is the largest natural gas users in the world (Louisiana's industrial and power generation use as large as China's)

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Hurricanes and Energy Production, Processing, and Transportation

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Summary on Impacts of Hurricanes

- **Hurricanes clearly drove home what a natural disaster-created event could do to the energy sector—real-world "worst-case event" —happened in the worst possible area (GOM) at the worst possible time (summer).**

- **Hurricanes were incredibly destructive to the energy business. Catastrophic destruction was experienced in all sectors (infrastructure categories) in the region. Hard to believe that a man-made event could be as broad.**

- **Hurricanes clearly showed the interrelationship of all types of energy infrastructure in the Gulf – the "4 Ps" – Production, Processing, Pipes, and Power.**

- **Hurricanes' impacts nationally and internationally droves home the importance of the Gulf coast and critical energy infrastructure.**

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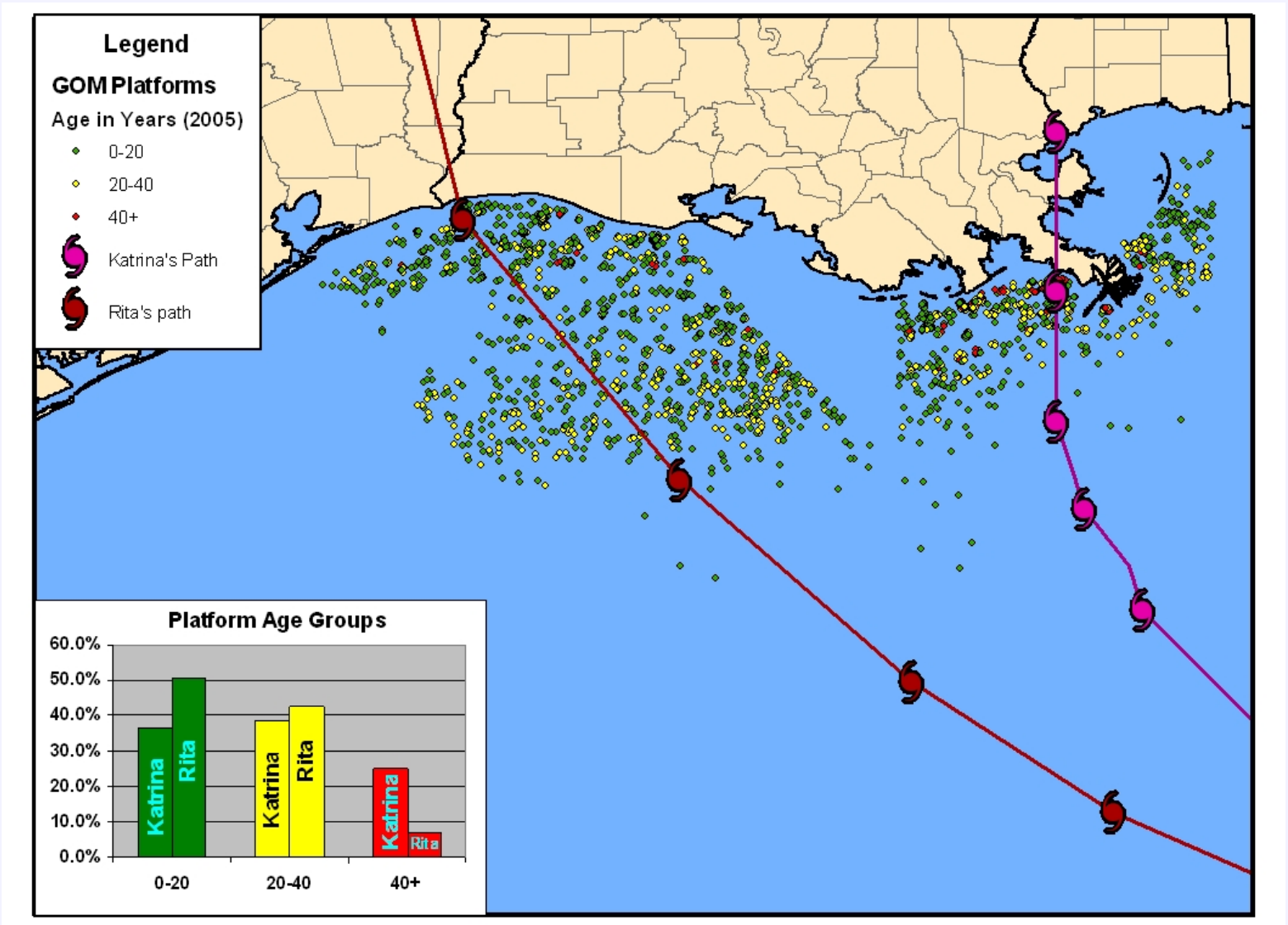
Platforms/Structures Impacted by 2005 Hurricanes



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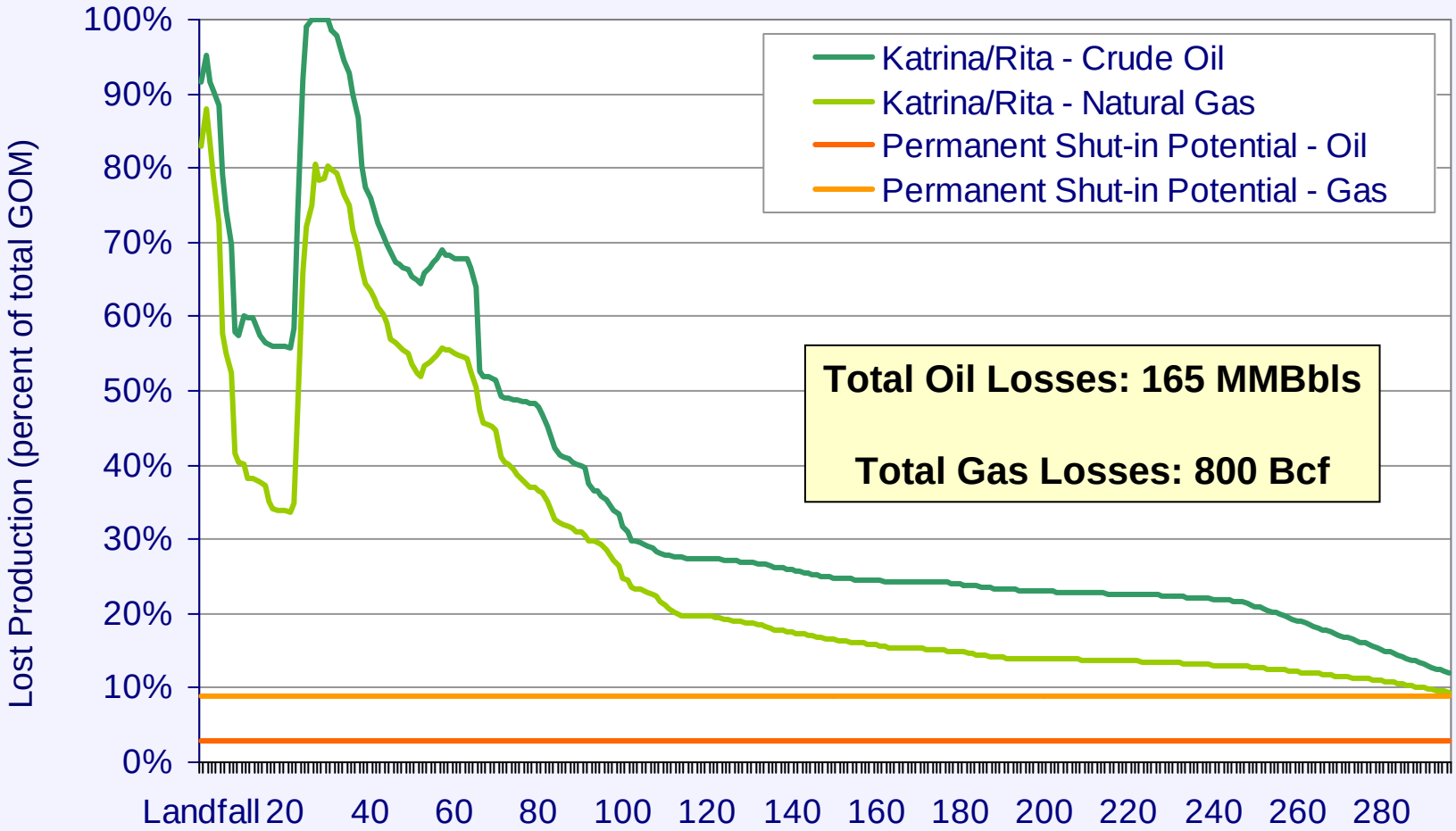
Estimated Return of Existing Crude Oil and Natural Gas Production

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



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 21 June 2006 (the 296th day after Katrina made landfall). Total pre-hurricane crude production of 1.5 MMBBls/d and gas of 10 Bcf/d.

Source: Minerals Management Service, U.S. Department of the Interior

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Impacted Natural Gas Pipeline Systems

A significant number of crude and natural gas pipelines suffered damage during the storm, interrupting production and delivery of energy commodities to market.

Operator	Diameter (inches)	Product	Operator	Diameter (inches)	Product
Tennessee Gas Pipeline Co	26	Gas	Southern Natural Gas Co	12-24	Gas
Tennessee Gas Pipeline Co	26	Gas	Equilon Pipeline Company LLC	12	Gas
Venice Gathering System LLC	26	Gas	Gulf South Pipeline Co LP	12	Gas
Venice Gathering System LLC	26	Gas	Apache Corporation	12	Bulk Oil
Southern Natural Gas Co	26	Gas	Equilon Pipeline Company LLC	12	Oil
Trunkline Gas Company LLC	24	Gas	Southern Natural Gas Co	12	Gas
Gulfterra Field Services LLC	20	Gas	Chevron Pipeline Co	12	Gas
Tennessee Gas Pipeline Co	20	Gas	Tennessee Gas Pipeline Co	12	Gas
Southern Natural Gas Co	20	Gas	Chandeleur Pipeline Co	12	Gas
Tennessee Gas Pipeline Co	20	Gas	Southern Natural Gas Co	12	Gas
Southern Natural Gas Co	18	Gas	SPN Resources LLC	10	Gas
Equilon Pipeline Company LLC	18	Oil	Transcontinental Gas Pipeline	10	Gas
Equilon Pipeline Company LLC	18	Oil	Total E&P USA Inc	10	Gas
Equilon Pipeline Company LLC	18	Gas	Apache Corporation	10	Gas
Chandeleur Pipeline Co	16	Gas	Apache Corporation	10	Gas
Marlin Energy Offshore LLC	14	Gas	Apache Corporation	10	Lift
Enbridge Offshore (Gas Gathering)	14	Gas	Apache Corporation	10	Gas
Southern Natural Gas Co	14	Gas	Exxon Mobil Corporation	10	Gas

Source: Minerals Management Service, U.S. Department of the Interior

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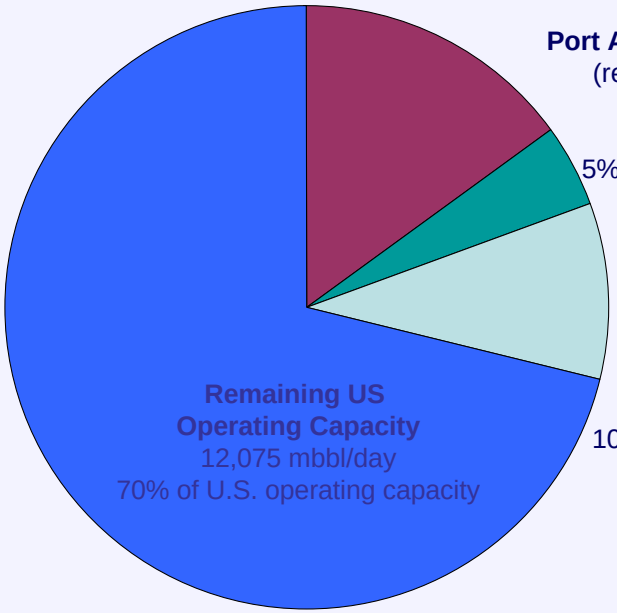
Total Immediate Refinery Impact

Hurricane Katrina

LA/MS/AL Gulf Coast Refiners
(reduced runs and shutdowns)
2,528 mbbl/day
15% of U.S. operating capacity



Port Arthur/Lake Charles
(reduced runs and supply loss)
775 mbbl/day
5% of U.S. operating capacity

Midwest
(reduced runs—supplied by Capline Pipeline)
1,628 mbbl/day
10% of U.S. operating capacity

Total Refinery Impact
4,931 mbbl/day
30% of U.S. operating capacity

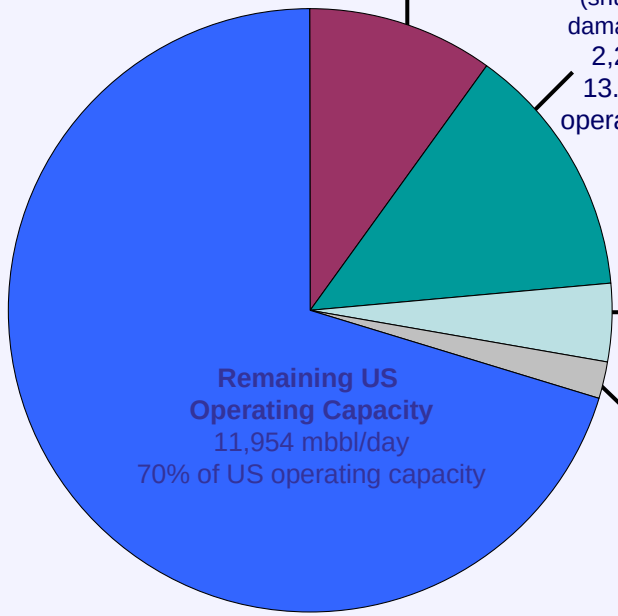
Hurricane Rita

Port Arthur/Lake Charles
(shutdowns and damaged facilities)
1,715 mbbl/day
10% of U.S. operating capacity

Houston/Texas City
(shutdowns and damaged facilities)
2,292 mbbl/d
13.5% of U.S. operating capacity

Corpus Christi
(shutdown and reduced runs)
706 mbbl/day
4% of U.S. operating capacity

Midwest
(reduced runs from supply loss)
338 mbbl/day
2% of U.S. operating capacity



Total Refinery Impact
5,052 mbbl/day
30% of U.S. operating capacity

Source: Energy Information Administration, Department of Energy

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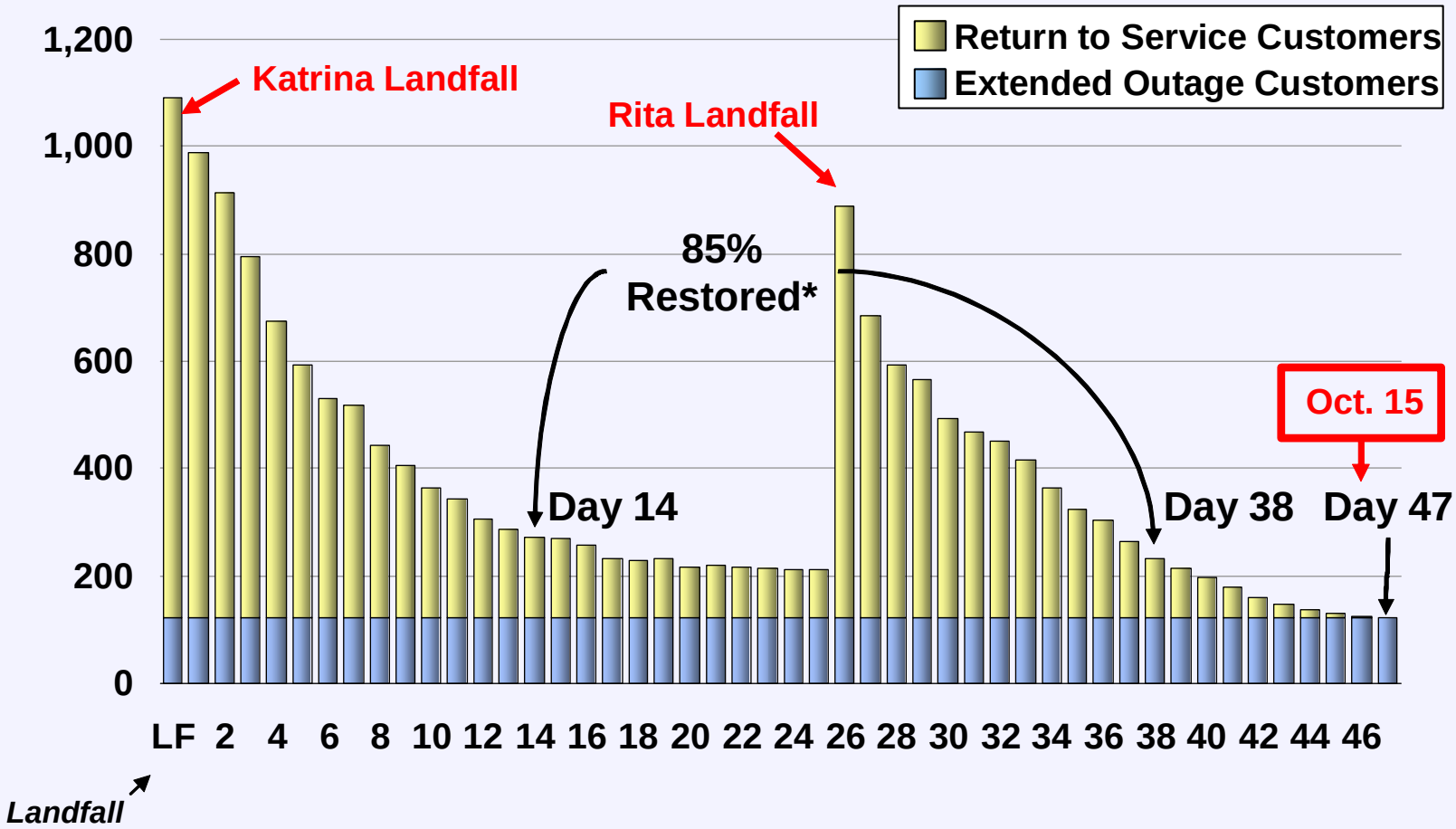
Power Outages from Hurricanes

Damage to power infrastructure (transmission) extensive. Restoration was monumental and impressive, but still created "nervous" moments for other energy infrastructure.



Source: Entergy Corp.

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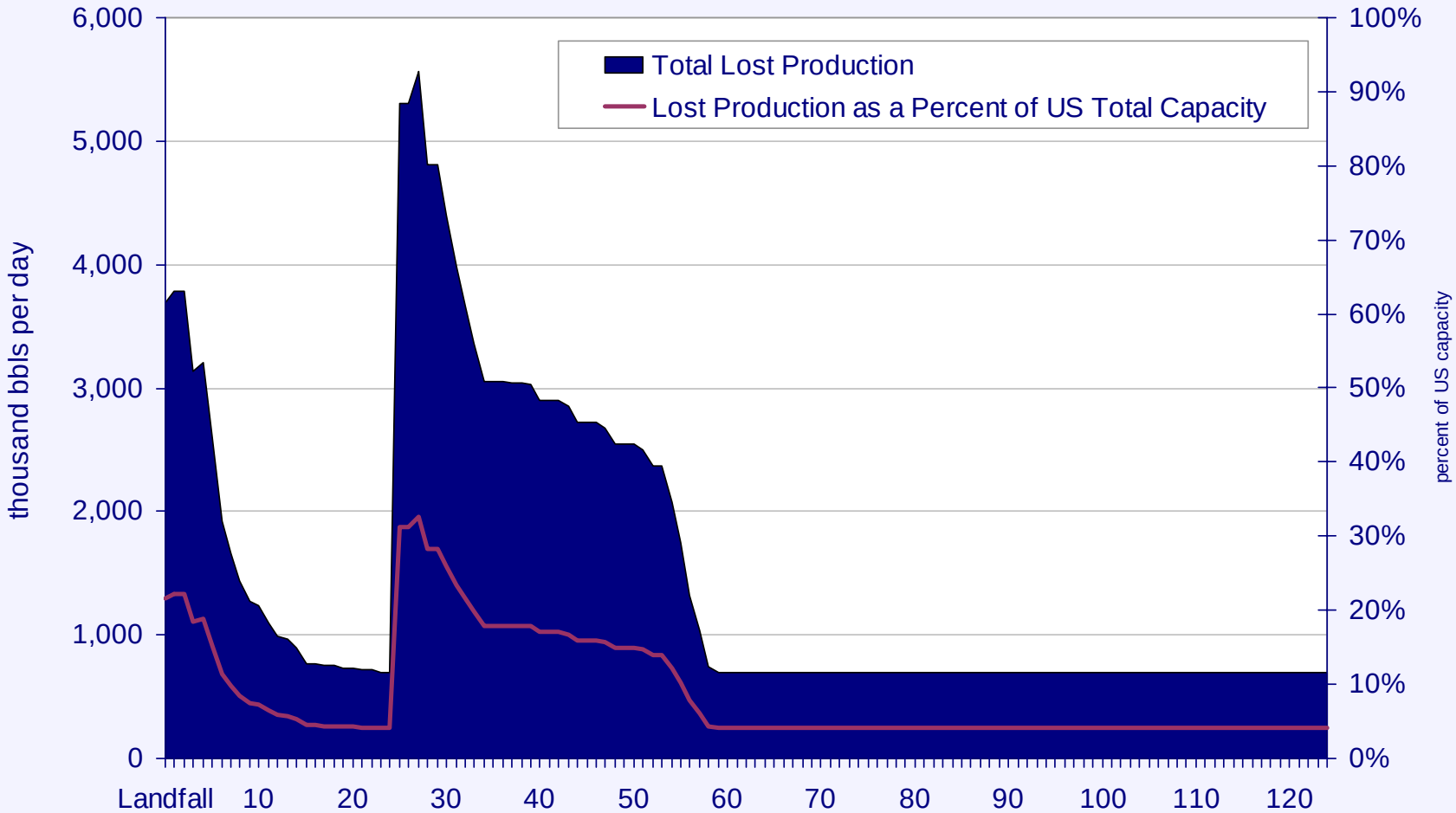
Estimated Decrease in Refining Production from both Katrina and Rita – First 120 Days

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.

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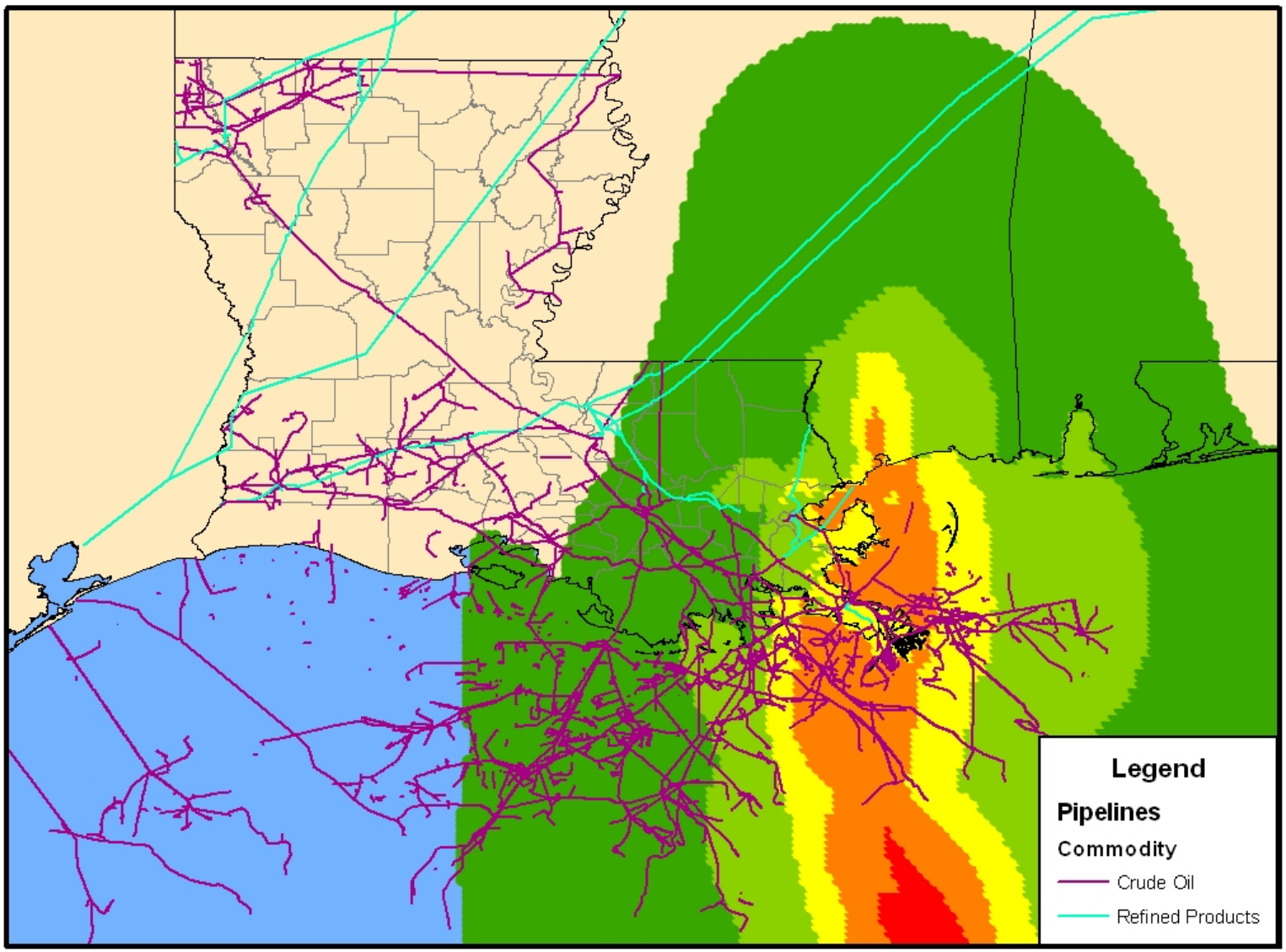
Crude and Product Pipelines Impacted by Katrina



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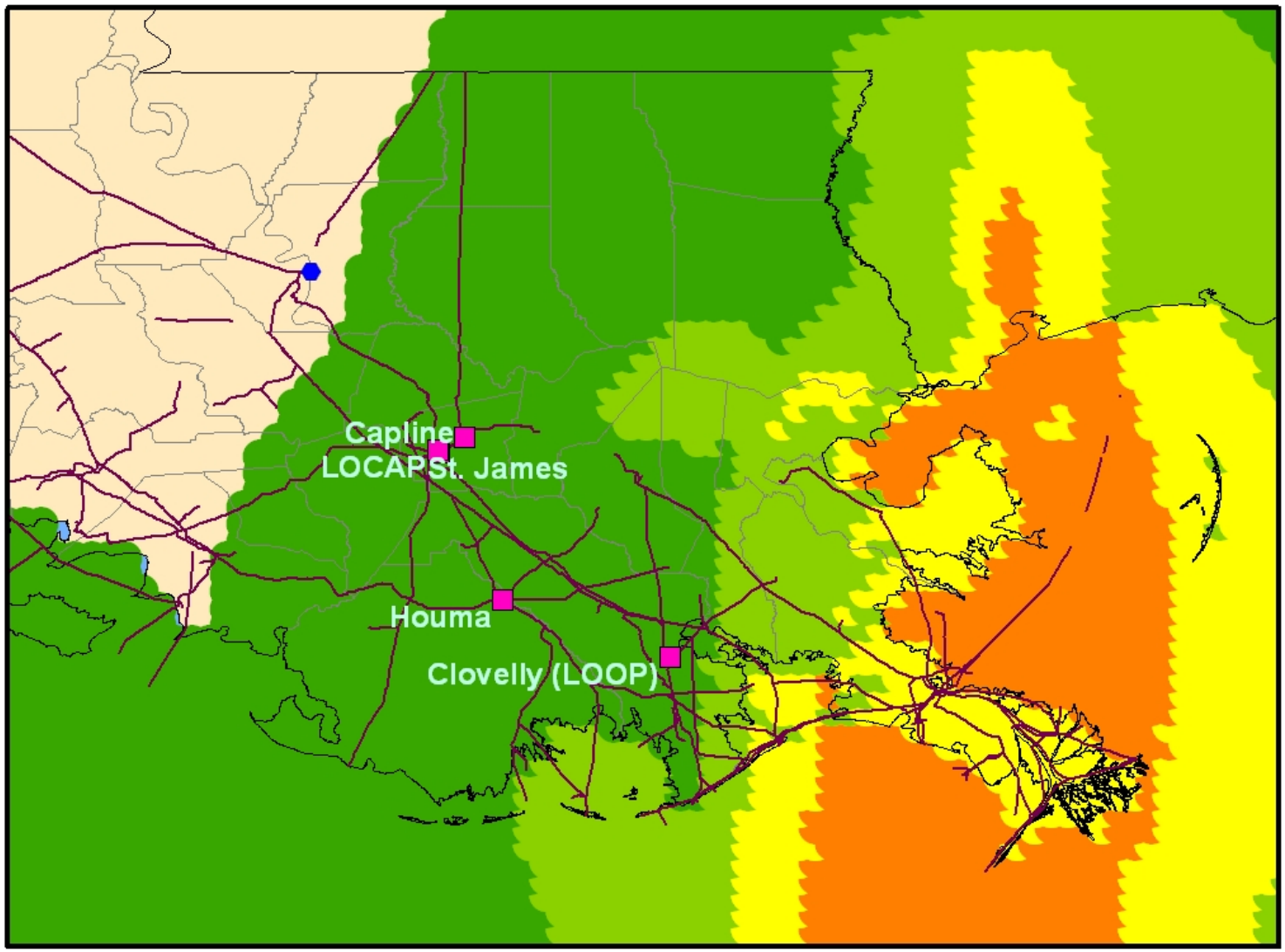
Critical Terminals Impacted by Katrina



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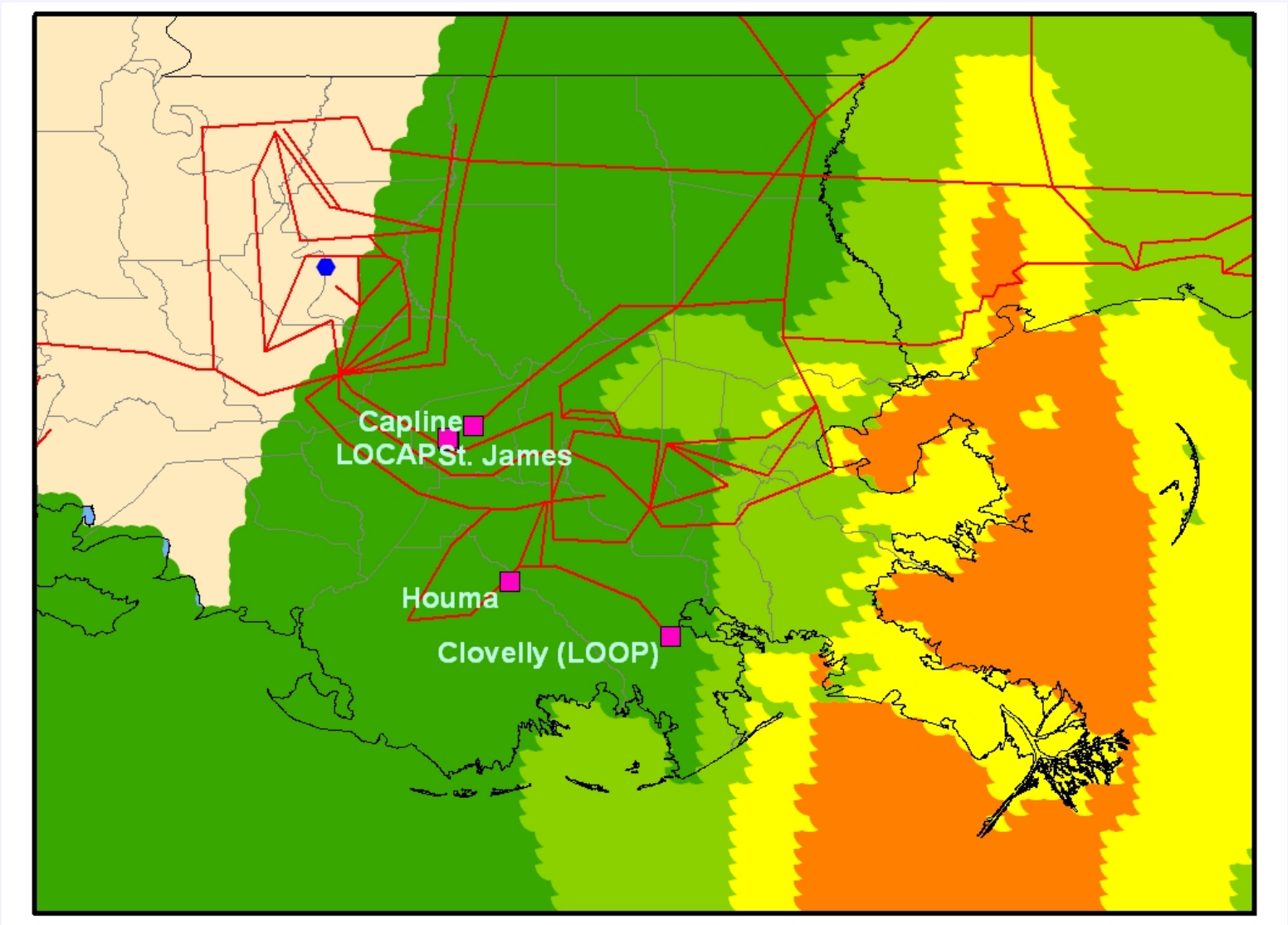
Critical Electricity Transmission Lines Impacted by Katrina



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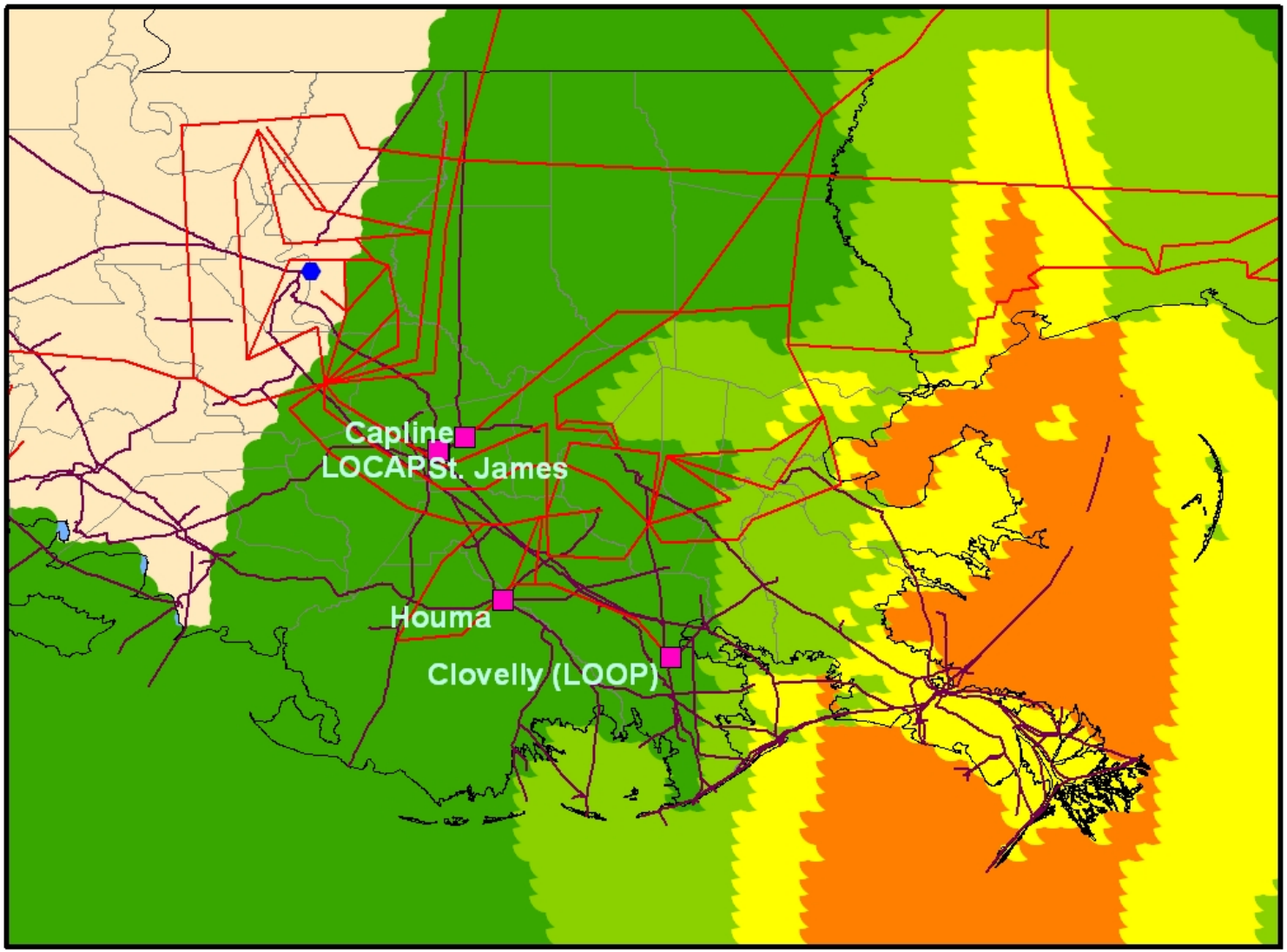
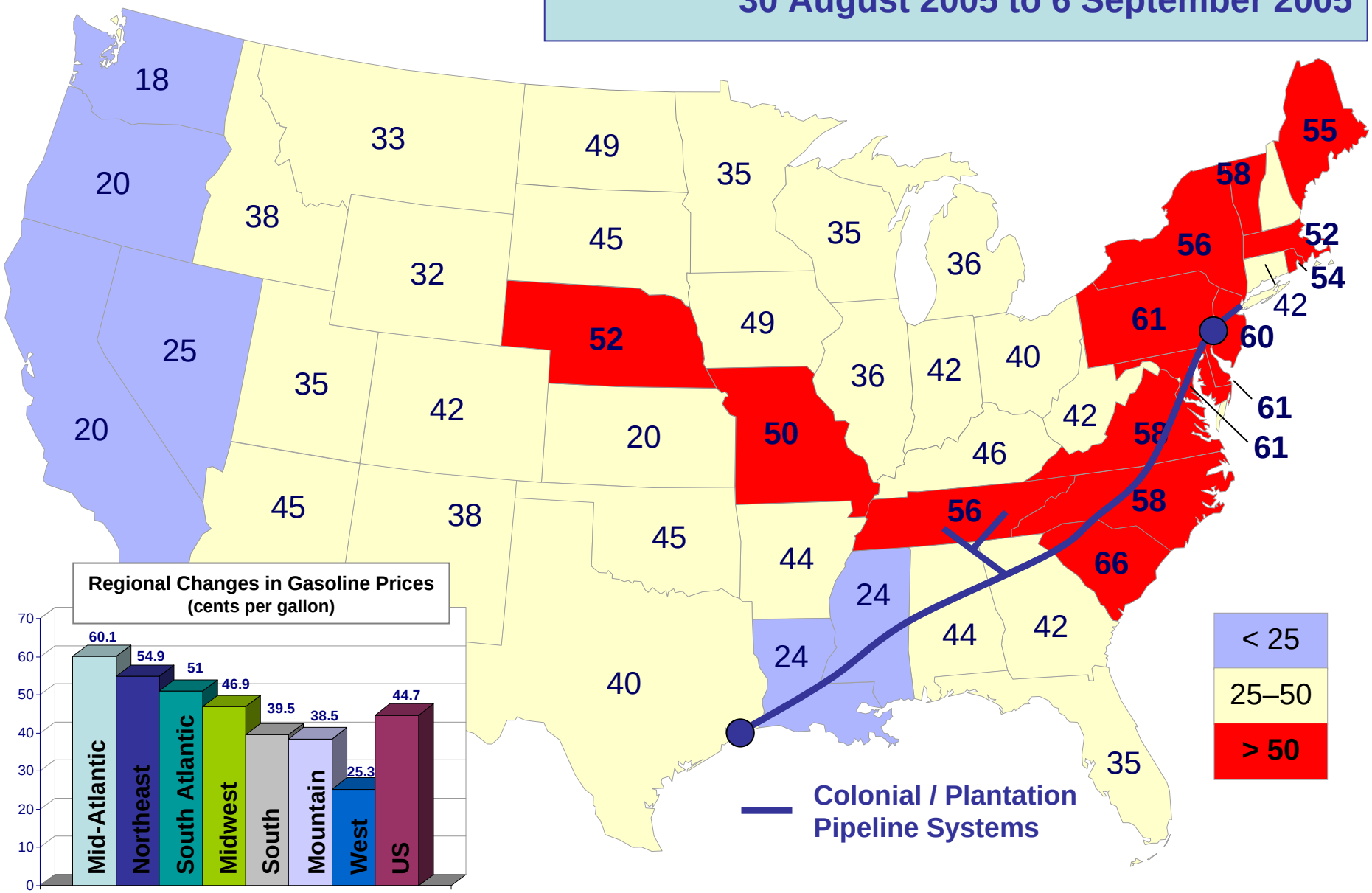
Critical Terminals and the Power-Pipeline Infrastructure



Gasoline Price Increases
30 August 2005 to 6 September 2005



Source: American Petroleum Institute

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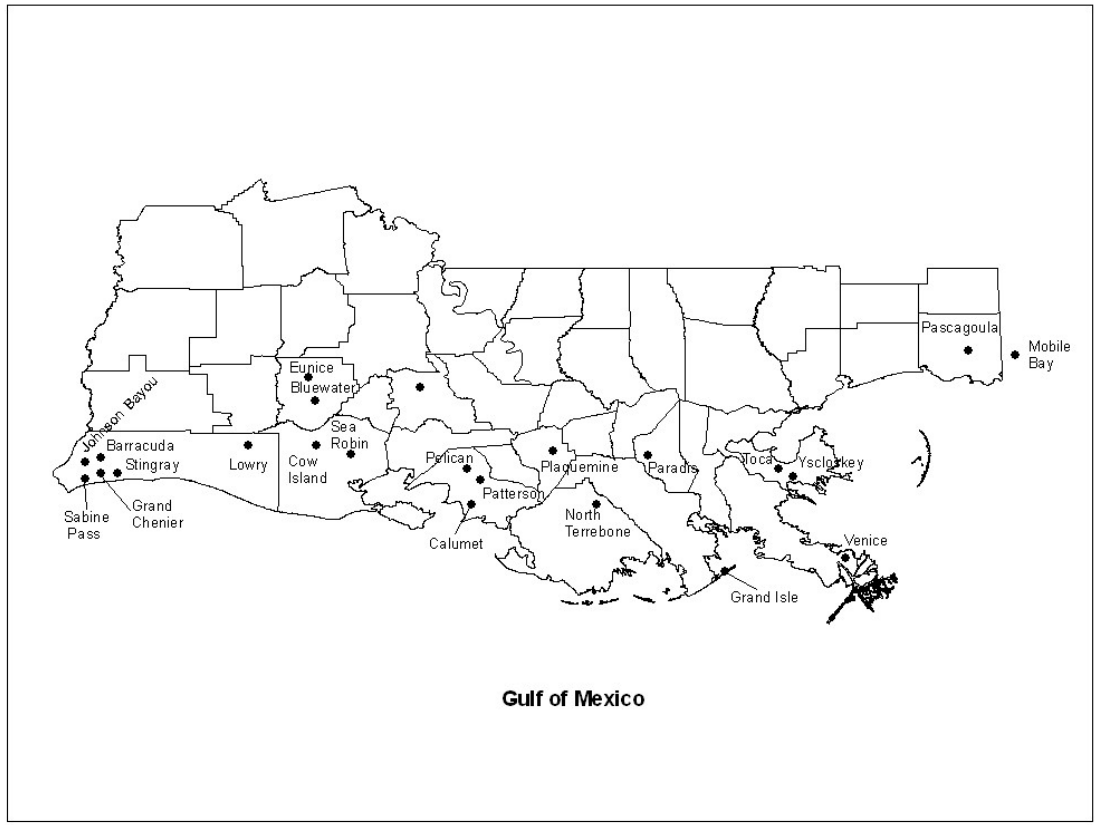
Number of Natural Gas Processing Facilities Out

Outages at gas processing facilities throughout all of south Louisiana was one of the more unusual aspects of the combined hurricanes.

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



Source: Oil and Gas Journal; Energy Information Administration, Department of Energy

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Petrochemical Plants Affected by Hurricanes Katrina and Rita

Outages were a combination of damage and input interruptions—particularly on the availability of natural gas, which post-Rita was significant.

Peak Percent Capacity Shut Down by Each Storm per Sector		
	Hurricane Katrina	Hurricane Rita
Ethylene	16%	59%
Propylene	19%	31%
Benzene	20%	69%
Polyethylene	4%	63%
Styrene	29%	85%
Butadiene	9%	96%

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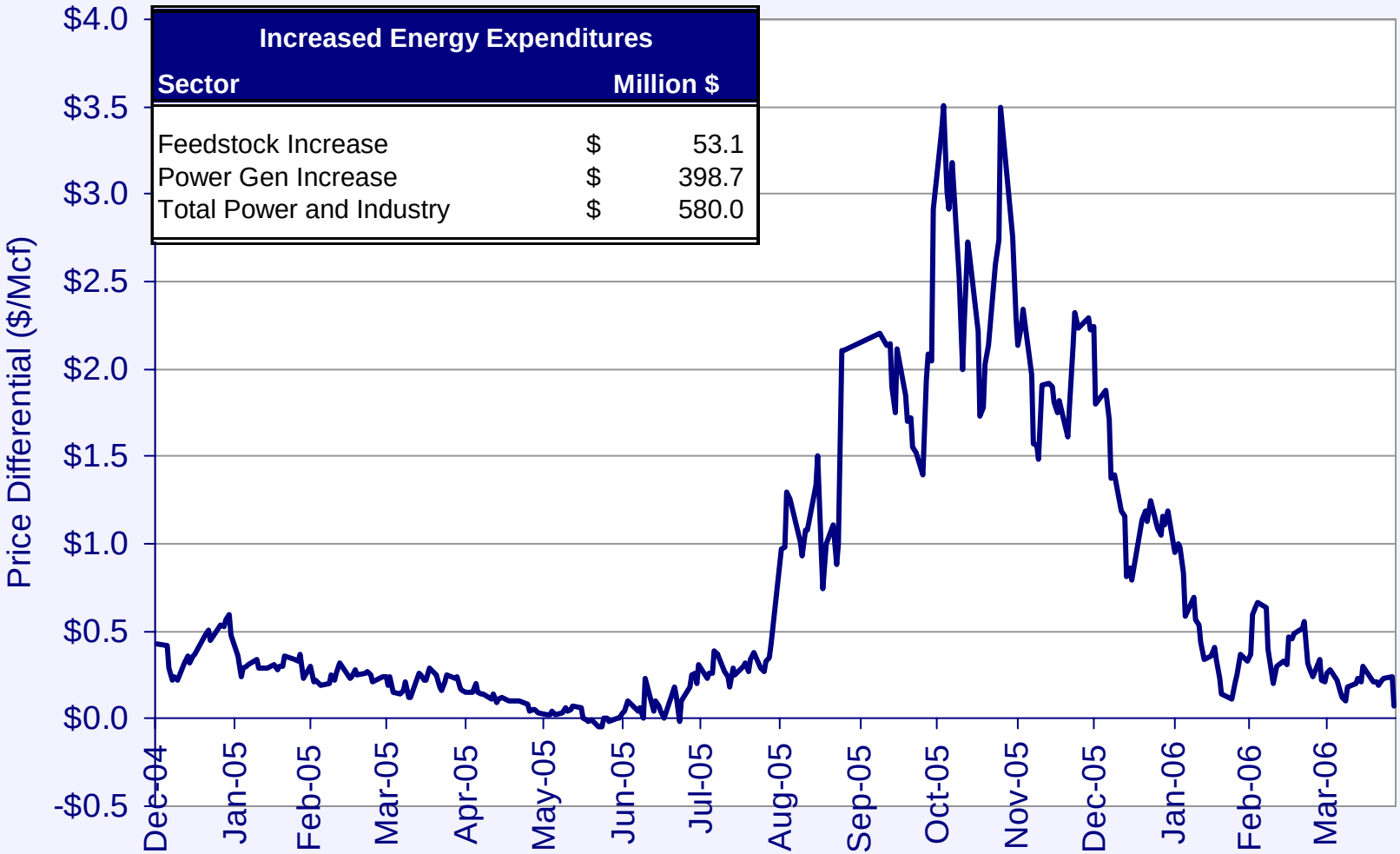
Henry Hub and Houston Ship Channel Differential

Estimated energy expenditures increased dramatically for industry and utility customers in aftermath of hurricanes due to limited local supplies.

Increased Energy Expenditures		
Sector		**Million $**
Feedstock Increase	$	53.1
Power Gen Increase	$	398.7
Total Power and Industry	$	580.0



Note: CES estimated energy expenditures based upon daily 2005 average usage (for illustrative purposes only since usage is unadjusted for hurricane-related interruptions).

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Proven System Resiliency

- All refineries seriously impacted by the hurricane are operational.
- Most gas pipelines have been repaired or alternative routes/service have been secured for most shippers.
- All petrochemical facilities are operational.
- All service basis and ports are operational. Some in Mississippi at 70–80% capacity.
- Electricity restored to all homes that can take service within two weeks (some 2.7 million without power Day 1 after Hurricane Katrina)
- To date, all but one gas processing facility is back on line.
- Most all crude oil production and natural gas production is back on line in GOM.
  – Crude oil shut-in: 179 MBbls/d (12%).
  – Natural gas shut-in: 936 MMcf/d (9%).

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Examples of Energy Infrastructure Damage (Katrina)

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Shell Mars Tension Leg Platform

Source: Shell.com

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Shell Mars Tension Leg Platform

Source: Shell.com

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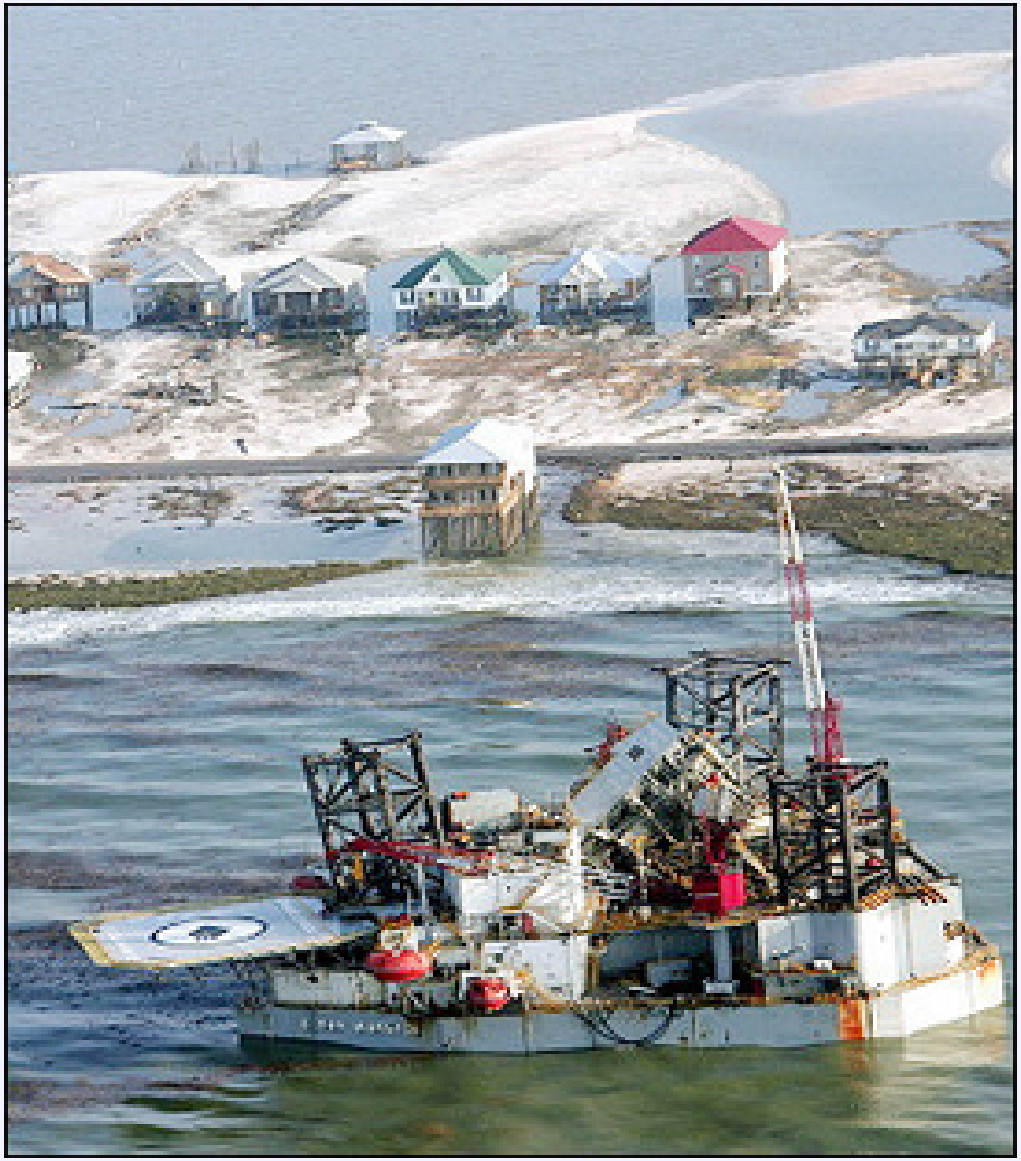
Ocean Warwick
Dauphin Island, Alabama



Source: Rigzone.com

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Semi-Sub Stuck Under Bridge North Mobile Bay

Source: Rigzone.com

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Venice Port
Supply & Crew Bases

Source: LIOGA

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Chevron Refinery
Pascagoula, Mississippi

Source: Chevron

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Air Products Facility – Normal Day
New Orleans, Louisiana (Intracoastal Drive)

Source: Air Products

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Air Products Facility – During Hurricane Katrina
New Orleans, Louisiana

Source: Air Products

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Air Products Facility – Post Hurricane Katrina
New Orleans, Louisiana

Source: Air Products

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Power Outages
Generating Stations – Entergy Patterson

Source: Entergy

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Power Outages
Substation Damage

Source: Entergy

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Rita-Created Infrastructure Damage

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Henry Hub, 25 September 2005

Source: LIOGA

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Entergy Transmission

Source: Entergy.com

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Citgo Refinery – Storage Tank
Lake Charles, Louisiana, Post-Rita

Source: Citgo

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

Source: Citgo

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

Source: Citgo

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Citgo Refinery – Tent City
Lake Charles, Louisiana, Post-Rita

Facility rental of $3.5 million for three weeks for 250 employees—roughly $156 per day per person.

Source: Citgo

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Natural Gas Pipeline Leak

Temporary Natural Gas Release. To date, all subsea 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.

Source: MMS

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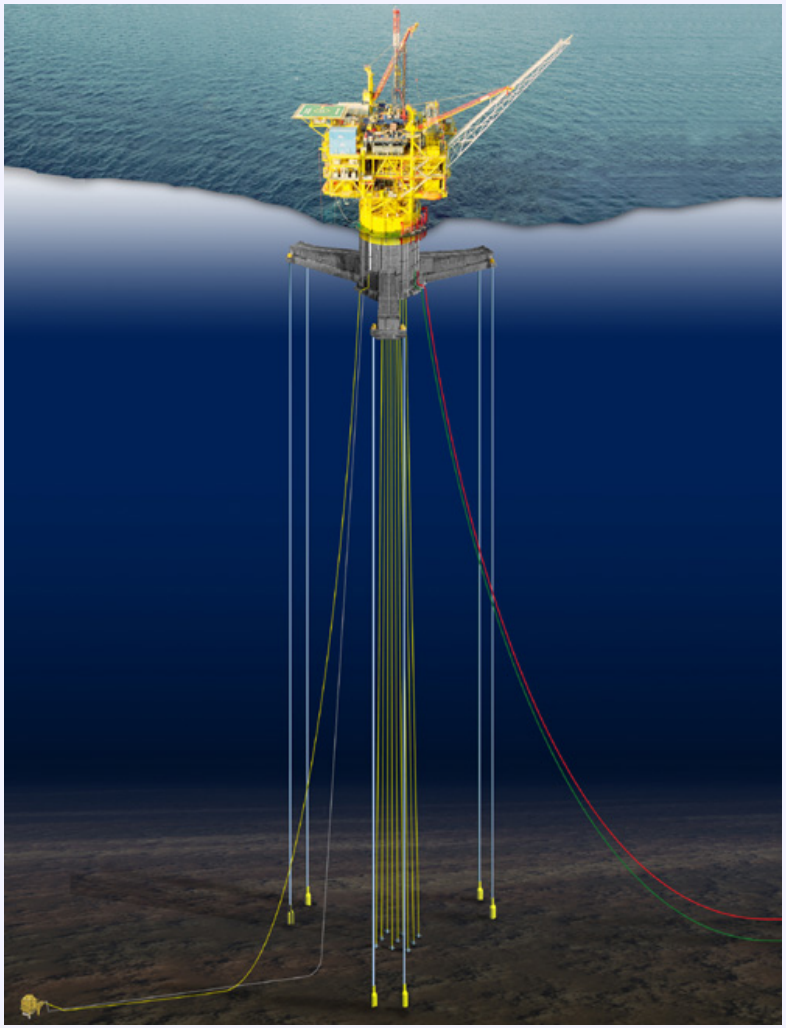
Chevron Typhoon TLP



Source: Chevron, Rigzone.com

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Increasing Emphasis on New Infrastructure Development (Greenfield and Expansion)

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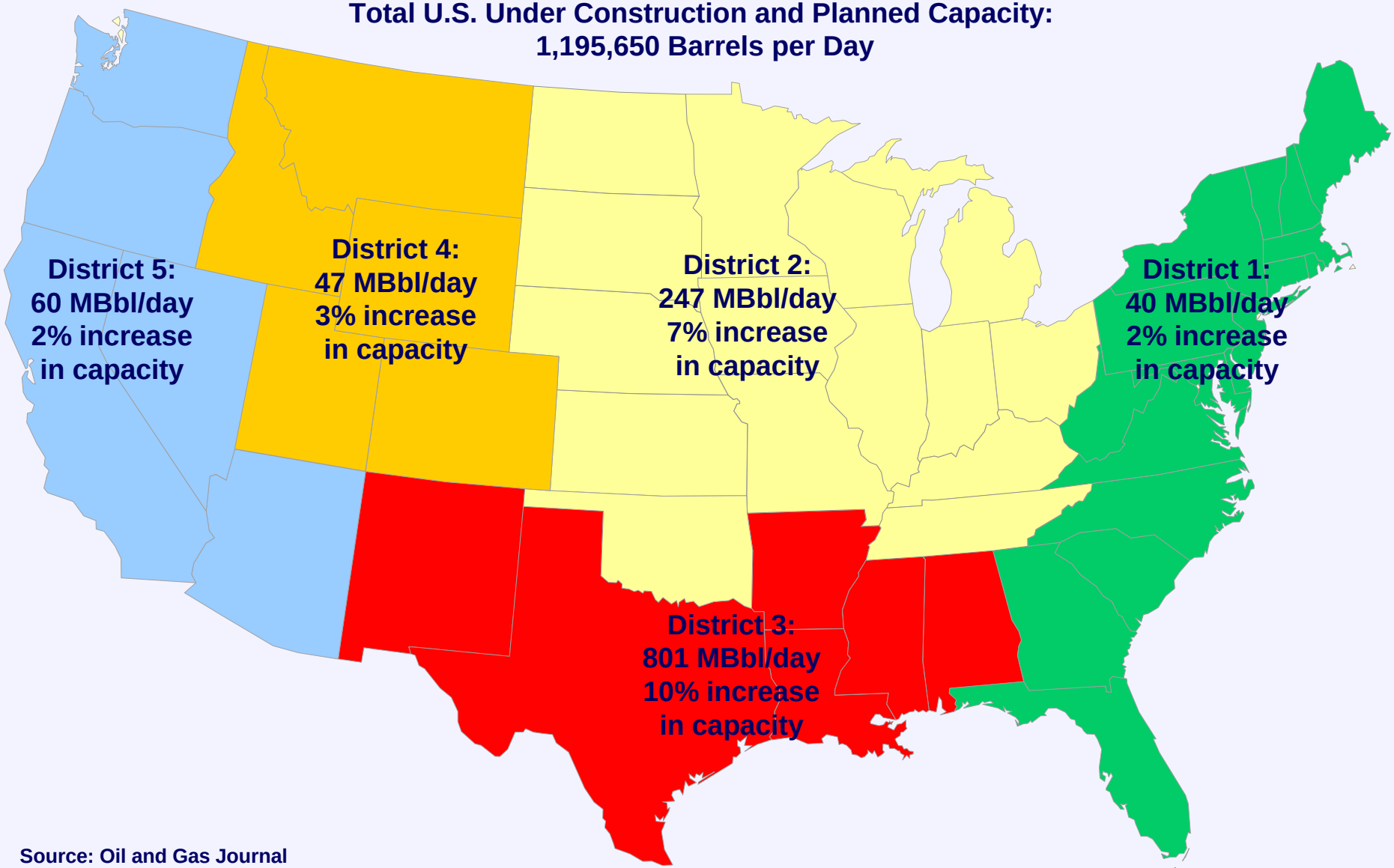
Under Construction and Planned Refining Capacity in the U.S.

Total U.S. Under Construction and Planned Capacity:
1,195,650 Barrels per Day



Source: Oil and Gas Journal

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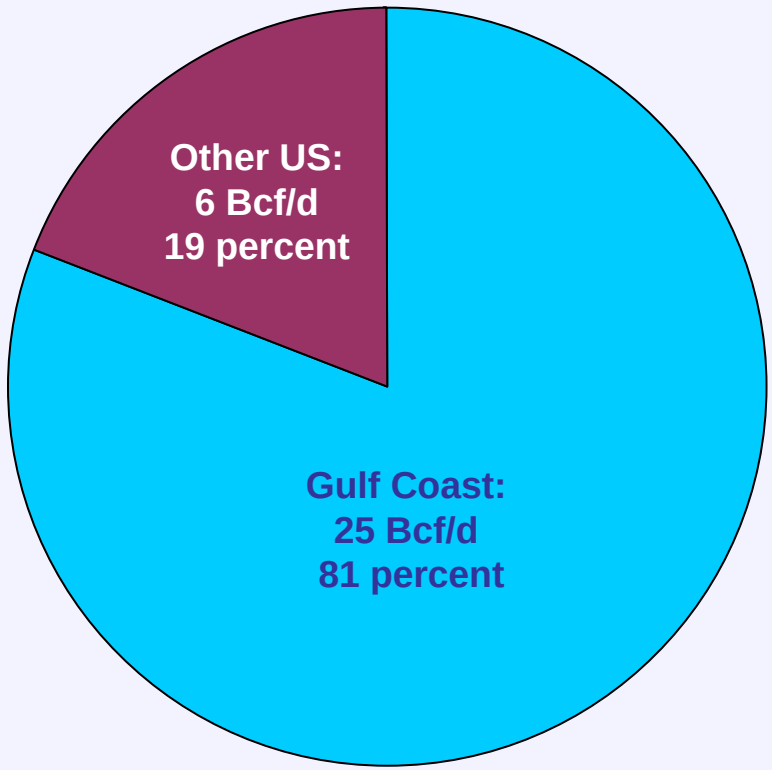
Existing and Approved LNG Terminals Share of Gulf Coast Region

Considerable development of LNG. Some 31 Bcf/d of capacity is current approved or under construction.



Source: Federal Energy Regulatory Commission

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Petrochemical and Gas Processing Plant Announcements

Company	Location	Project	Added Capacity	Status	Expected Completion
Petrochemicals					
AS Alliances	Ohio	Ethanol	100 million gallons per year	n.a.	2007
AS Alliances	Nebraska	Ethanol	100 million gallons per year	n.a.	2007
AS Alliances	Indiana	Ethanol	100 million gallons per year	n.a.	2007
Cargil Inc	Nebraska	Ethanol	110 million gallons per year	Planning	2007
US BioEnergy Corp	Iowa	Ethanol	100 million gallons per year	Construction	2006
US BioEnergy Corp	Minnesota	Ethanol	100 million gallons per year	Planning	2007
Gas Processing					
Energy Transfer Partners	Johnson Cnty, TX	Gas Plant	115 MMcf per day	Construction	2006
Energy Transfer Partners	Johnson Cnty, TX	Gas Plant	170 MMcf per day	Planning	2007
Enterprise Products Partners	Hobbs, NM	NGL Fractionation	75 thousand barrels per day	Engineering	2007
Enterprise Products Partners	Mont Belvieu, TX	NGL Fractionation	60 thousand barrels per day	Planning	
Enterprise Products Partners	Mont Belvieu, TX	NGL Fractionation	480 thousand barrels per day	Construction	2007
Enterprise Products Partners	Mont Belvieu, TX	NGL Fractionation	160 thousand barrels per day	Construction	2007
Enterprise Products Partners	Opal, WY	Gas Plant	650 MMcf per day	Engineering	2007
Enterprise Products Partners	Rio Blanco, CO	NGL	750 MMcf per day	Construction	2007
Trunkline LNG	Lake Charles, LA	NGL	n.a.	Planning	2008

Source: Oil & Gas Journal

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GOM Region Pipeline Construction Projects Completed in 2005

State(s)	Pipeline / Project Name	Type of Project	In Service/ Status	Estimated Cost (million $)	Miles	Additional Capacity (MMcf/d)
FL	Gulfstream Pipeline - System Ext Ph 2	Extension	Dec-04	$ 237	110	175
MS	Petal Gas Storage - Compressor Upgrade	Compression	May-05	$ 1	-	620
GOM	Excelerate - Energy Bridge Connector	Lateral	Mar-05	$ 5	8	690
GOM	Discovery - Hunt ST 254 Line	Lateral	Apr-05	$ 4	3	15
GOM	Discovery - Rock Creek ST 41 Line	Lateral	Apr-05	$ 5	2	100
GOM - LA	Discovery - Market Expansion Project	Looping/Compression	Jul-05	$ 11	3	150
LA	Trunkline - Lake Charles Lateral Loop	Looping	Oct-05	$ 40	23	1,100
LA	Regency - Northern Louisiana Expansion	Looping/Compression	Dec-05	$ 140	120	615
TX	Dominion South - FGT Interconnect	Lateral	Dec-05	$ 2	-	200
TX	Enbridge Pipelines - East Texas Pipeline	New Pipeline	May-05	$ 130	107	500
TX	Quicksilver Resources - Cowtown Gathering	New Pipeline	Jul-05	$ 15	35	75
TX	Energy Transfer - Fort Worth Basin Pipeline	New Pipeline	Jun-05	$ 53	54	650
TX	Kinder Morgan - Rancho Pipeline Phase II	Conversion	Oct-05	$ 40	254	150
TX	Atmos Energy - North Side Loop West Side	New Pipeline	May-05	$ 24	22	200
				Total:	**741**	**5,240**

Source: Energy Information Administration, US Department of Energy

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GOM Region Proposed Pipeline Projects 2006 and 2007

State(s)	Pipeline / Project Name	Type of Project	In Service/ Status	Estimated Cost (million $)	Miles	Additional Capacity (MMcf/d)
GOM	Okeanos Gathering - Thunder Horse Segment	Extension	Construction		26	1,200
LA	Liberty Gas Storage Lateral	Lateral	Approved		23	1,000
GOM	EPP - Independence Trails Offshore Line	New Pipeline	Construction		134	1,000
TX	Energy Transfer Co - Barnett-Texoma Pipeline	New Pipeline	Construction		264	700
TX	Energy Transfer Co - Fort Worth Basin	Looping/Compression	Construction		24	400
GOM	Cleopatra Gathering System Ph 2	Gathering Lateral	Construction		21	375
TX	Crosstex - Fort Worth Basin Pipeline	New Pipeline	Completed		122	250
GOM	TGP - Triple-T Extension	Lateral	Approved		6	200
TX	Atmos - North Side Loop East Side	New Pipeline	Approved		25	200
GOM	EPP - Constitution Gathering Pipeline	Gathering	Completed		32	200
TX - LA	Gulf South - East Texas Expansion	Looping/New Pipe	Prefiling		180	1,500
LA - MS	Gulf South - Mississippi Expansion	Looping/Replace	Prefiling		86	1,500
TX - LA	Centerpoint - Perryville Expansion	New Pipeline	Applied		177	1,237
GOM	TGP - Deepwater Link	New Pipeline	Approved		1	1,000
TX	Energy Transfer Co - Barnett-Texoma Exp	Looping/Compression	Approved		157	950
LA	Crosstex Energy - LIG Expansion	Extension	Planning		65	700
TX - LA	Kinder Morgan - Carthage Line	New Pipeline	Planning		38	700
TX	Enbridge - East Texas System Expansion	Extension	Approved		290	700
MS	SGR Holdings - Southern Pines Storage	Extension	Construction		32	600
LA	Pine Prairie Storage	Looped Lateral	Construction		24	600
LA - MS	Columbia Gulf - East Lateral Ext	Extension	Planning		90	500
				Total:	**1,817**	**15,512**

Source: Energy Information Administration, US Department of Energy

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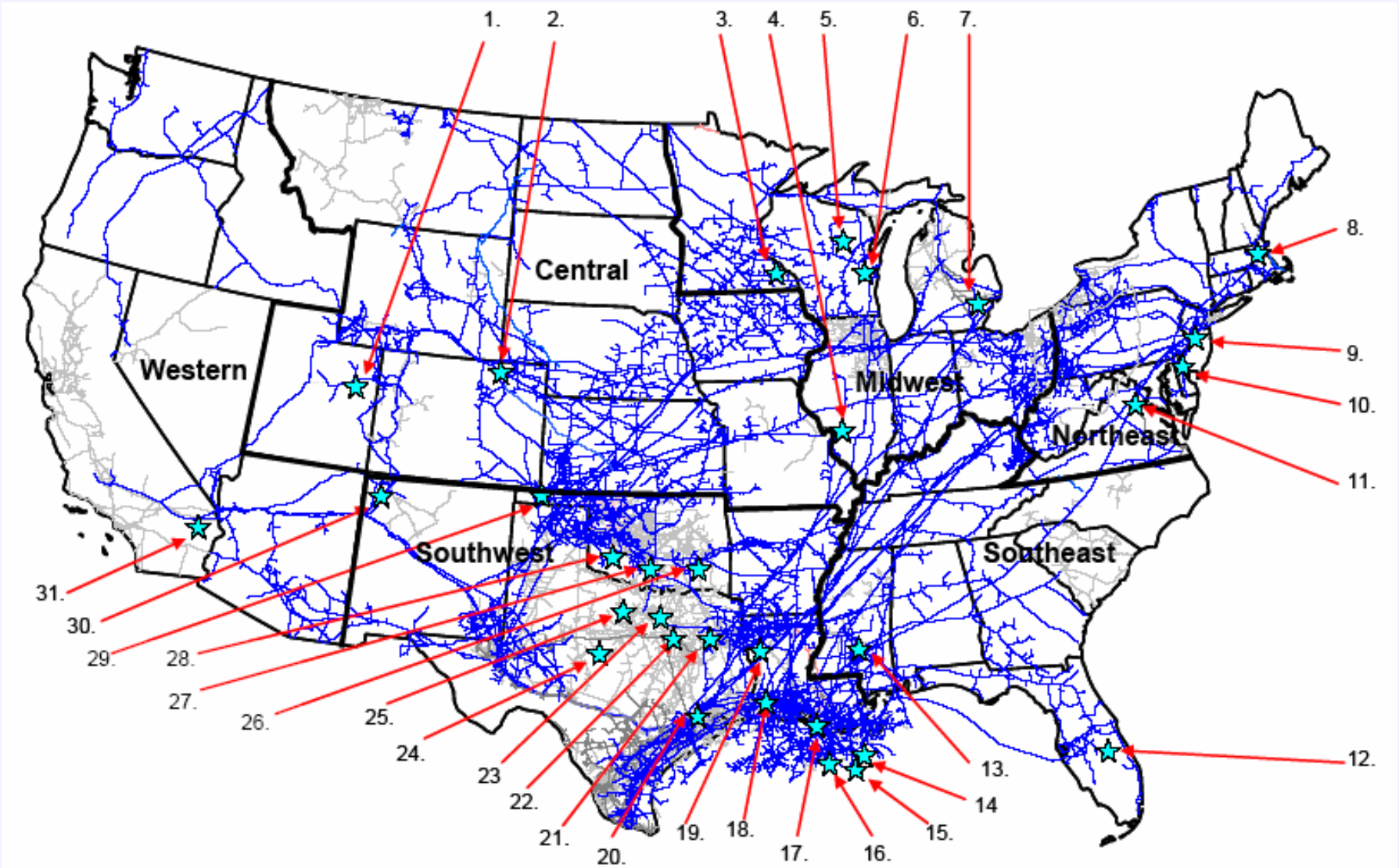
Natural Gas Pipeline Construction Projects Completed in 2005



Source: Energy Information Administration, US Department of Energy

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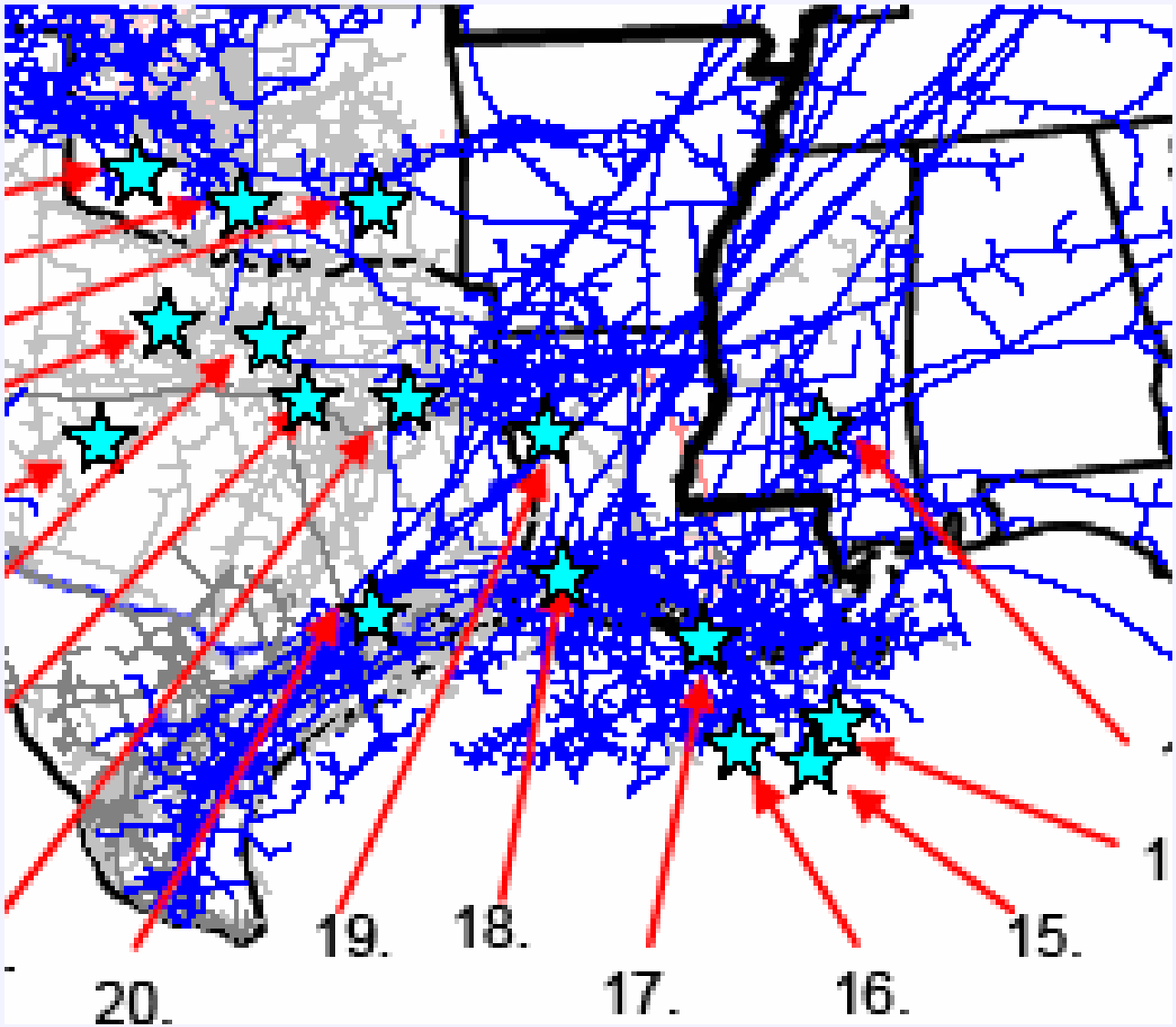

Source: Energy Information Administration, US Department of Energy

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Conclusions

- GOM region has played an important historic role in the development of energy infrastructure. This is 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.
- There are some concerns about “diversifying” the energy infrastructure in the region. Given current economic challenges, the concern is that diversity in some infrastructure areas could “diversify” to other parts of the world, which would actually increase U.S. vulnerability, not decrease it.
- Man-made and catastrophic incidents should not be taken lightly—but should require a more probabilistic approach to mitigation—more than likely a resiliency as opposed to a “hardening” solution.
- Clearly, industry and investors continue to be willing to put billions into investments in this region on a forward-going basis. This speaks volumes about continued viability of the region from energy production, processing and transportation perspective.

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