TO: THE QER SECRETARIAT

FROM: THE ENTERGY OPERATING COMPANIES

SUBJECT: COMMENTS ON THE QUADRENNIAL ENERGY REVIEW APRIL 11, 2014 PUBLIC MEETING "ENHANCING INFRASTRUCTURE RESILIENCY AND ADDRESSING VULNERABILITIES," HELD IN WASHINGTON, DC

DATE: OCTOBER 10, 2014

The Entergy Operating Companies[1] ("Entergy") appreciate the opportunity to comment on the questions outlined in the briefing memo dated April 2, 2014, posted in association with the Quadrennial Energy Review Public Meeting "Enhancing Infrastructure Resiliency and Addressing Vulnerabilities," held on April 11, 2014, Washington, DC.

These comments, and the graphs and information included herein, are taken from studies, reports, and meetings with stakeholders that Entergy has engaged in and conducted over the past several years in an effort to address the very topics that were the subject of the April 11th meeting, how to address vulnerabilities to increasing risks in order to create a resilient system for the delivery of electric energy. Many of these studies and reports are publicly available via the links provided below. The posted information also includes information that has been gathered by Entergy and its project partners and, to some extent, studies commissioned by Entergy. However, not all statements found in the posted information directly reflect any policy or position held by Entergy.

References and Resources noted within these comments are described below, and posted on Entergy webpages dedicated to adaptation research and strategies, available at http://www.entergy.com/environment/adaptation.aspx and http://entergy.com/gulfcoastadaptation/, which include several reports with findings and recommendations for adaptation measures and their associated costs and benefits focusing on the Gulf Coast region, and addressing the topics on which the QER Secretariat has requested stakeholder feedback, including:

"Building a Resilient Energy Gulf Coast" Executive Report
http://www.entergy.com/content/our_community/environment/GulfCoastAdaptation/Building_a_Resilient_Gulf_Coast.pdf, presents the findings of analysis that quantifies climate risks in the U.S. Gulf Coast, and provides economically sensible approaches for addressing this risk and building a resilient Gulf Coast.

The **objective** of this work is to develop a consistent fact base that quantifies climate risks in the U.S. Gulf Coast and helps inform economically sensible approaches for addressing this risk. It represents the first comprehensive analysis of climate risks and adaptation economics along the U.S. Gulf Coast.

The **scope** of this analysis includes Coastal counties and parishes considering a strip of land up to 70 miles inland across the shoreline, ranging from southern Texas, to Coastal Mississippi and Alabama. The

[1] The Entergy Operating Companies are Entergy Arkansas, Inc., Entergy Gulf States Louisiana, L.L.C., Entergy, Texas, Inc., Entergy Louisiana, LLC, Entergy Mississippi, Inc., and Entergy New Orleans, Inc.

area of study includes: 800 zip codes across 77 counties and parishes, and covers a population of ~12 million people, and an annual GDP of ~$630 billion. (*See Executive Report Exhibit 1*).

The **methodology** used in this study was previously devised and tested by a consortium of public and private partners, including Swiss Re in a project on the Economics of Climate Adaptation (ECA). The methodology developed a framework for decision-makers to build a portfolio of economically suitable adaptation measures.

"Effectively addressing climate risk through adaptation for the Energy Gulf Coast"
http://entergy.com/content/our_community/environment/GulfCoastAdaptation/report.pdf
Objective: Develop a comprehensive, objective, consistent fact base to quantify climate risks in the U.S. Gulf Coast and inform economically sensible approaches for addressing this risk.

- A Granular, "bottom-up" analysis using a risk framework
  - – Modeled 23 asset classes across residential, commercial, infrastructure, oil, gas and utility
  - – Modeled 800 zip codes across 77 counties
  - – Simulated ~10,000 hurricane "years" across multiple climate scenarios
  - – Modeled over 50 adaptation measures
- The first time a broad range of Gulf Coast stakeholders and experts were engaged
  - – Discussed with over 100 global and regional academics, government officials, industry experts and NGOs
  - – Used credible, publicly available sources (e.g., IPCC climate scenarios, FEMA, BEA, DOE EIA, MMS, Energy Velocity)

"Beyond Unintended Consequences – Adaptation for Gulf Coast Resiliency and Sustainability"
http://www.futureofthegulfcoast.org/index.php
The final report of the America's WETLAND Foundation's Blue Ribbon Resilient Communities: Envisioning the Future of America's Energy Coast Initiative -- was released in 2012, containing 30 recommendations no how to help prepare our communities and preserve local economies.

During 2011 – 2012, the America's WETLAND Foundation and its America's Energy Coast partners focused on a new initiative: "Blue Ribbon Resilient Communities: Envisioning The Future of America's Energy Coast" (BRRC).

The BRRC was initiated in response to the growing vulnerabilities along the Gulf Coast in the wake of coastal land loss and degrading landscapes that threaten coastal populations and indigenous cultures. The livelihoods of 12 million people living near the coast, the sustainability of rich natural resources that support $634 billion in annual GDP, and the security of residential, commercial and industrial assets valued at more than $2 trillion are increasingly vulnerable to storm surge, flooding, wind damage, and the effects of sea level rise. Recent natural events like Hurricanes Katrina, Rita, Gustav, Ike and man-made disasters, such as the BP oil spill, provide a glimpse of what the future could bring if we don't plan for and invest in building more resilient, sustainable communities.

Blue Ribbon Resilient Communities/America's Energy Coast Leadership Forums were hosted in communities across the five Gulf States of Texas, Louisiana, Mississippi, Alabama and Florida. They assessed local vulnerabilities and empowered the region to envision, plan and act to ensure resiliency and sustain cultural, economic and ecological values in the face of growing coastal degradation. The series of forums will also strengthen the local voice and provided more authentic solutions to envisioning the future.

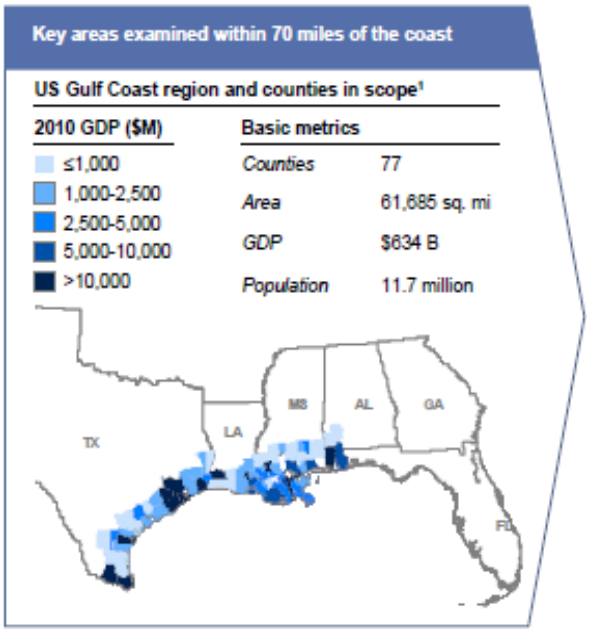
Entergy's Responses to Key Questions Regarding Energy System Vulnerabilities, outlined in the Department of Energy's April 2nd briefing memo:

Q.1. How do stakeholders view resilience challenges: what are the major vulnerabilities, what are available tools to address them, and where is policy intervention needed?

A.1.a. Major vulnerabilities – *these comments focus on the unique vulnerability of the Gulf Coast, and how this vulnerability impacts the US economy.*

To develop the "Building a Resilient Energy Gulf Coast" Executive Report, Entergy worked with risk assessment experts to develop a framework and fact base to quantify climate risks along the U.S. Gulf Coast and help inform economically sensible approaches for addressing this risk and building a resilient Gulf Coast.

The Study Area:



Source: ESRI; Energy Velocity

Project participants include Entergy, America's Energy Coast, America's Wetlands Foundation, and Swiss Re, which was a lead contributor to the research, and brought its natural catastrophe and climate risk assessment knowledge to bear on the challenge of quantifying climate risks. The methodology used in this study was previously devised and tested by a consortium of public and private partners, including Swiss Re in a project on the Economics of Climate Adaptation (ECA). The methodology developed a framework for decision-makers to build **a portfolio of economically suitable adaptation measures.**

In order to assess the risk posed to the Gulf Coast by climate change, ***hazards, economic value****, and* ***vulnerability assessments*** *were performed. More detail regarding these assessments is available in the Executive report. Hazards assessed include* hurricanes, subsidence and sea level rise. Future scenarios for hazards are developed in consultation with expert scientists in the field. The economic value

assessment estimated the size and location of current and future "assets" of economic value. The vulnerability assessment step *utilized* vulnerability curves relating value at risk to events of different severities. A vulnerability curve shows the correlation between hurricane severity and asset loss, where asset loss is presented as a proportion of total asset value. Categories of assets typically have different vulnerability curves (for example, residential property may look quite different from utility assets in its vulnerability to extreme winds).

The Gulf Coast is vulnerable to growing environmental risks today with >$350 billion of cumulative expected losses by 2030

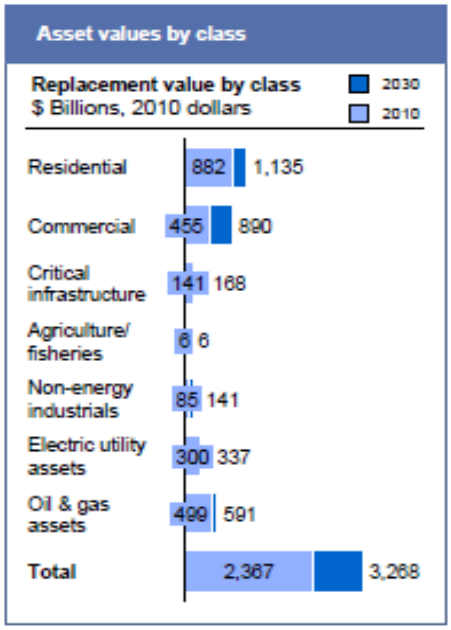
- **Economic losses will increase by 50-65 percent in the 2030 timeframe driven by *continued* economic growth *in the region,* subsidence, *and* the impacts of climate change:** Wind and storm surge damage from hurricanes drives significant losses in the Gulf Coast today. While the actual losses from extreme storms are uncertain in any given year, on average, the Gulf Coast faces annual losses of ~$14 billion today

- **Over the next 20 years, the Gulf Coast could face cumulative economic damages of some $350 billion:** 7 percent of total capital investment for the Gulf Coast area and 3 percent of annual GDP will go towards reconstruction activities. In the 2030 timeframe, hurricane Katrina/Rita-type years of economic impact may become a once in every generation event as opposed to once every ~100 years today. The impact of severe hurricane in the near-term could also have a significant impact on any growth and reinvestment trajectory in the region

As described in further detail in the Building a Resilient Energy Gulf Coast Executive Report, the Gulf Coast faces significant risks from hurricanes that extensively damage assets and impact the economy. Over the last century, hurricanes have caused asset damage of approximately ~$2,700 billion in 2010 dollars across Texas, Louisiana, Mississippi and Alabama. In addition to the risk from hurricanes, impacts due to relative sea level rise have also been assessed. Relative sea level rise can be driven by land subsidence and by climate change (rising sea levels) and can magnify storm surge impacts.

Cumulative annual expected losses in the Gulf Coast may amount to ~$345 billion in 2010 dollars without factoring climate change impacts and ~$370 billion in 2010 dollars between today and 2030 under an "average climate change scenario."

Asset class valuation along Gulf Coast:



Gulf of Mexico offshore assets key statistics as of 2010:

- More than 2,500 active shallow water platforms
- 145 active deepwater platforms
- ~14,000 miles of offshore pipelines

The Gulf Coast is vulnerable to growing environmental risks today with >$350 billion of cumulative expected losses by 2030:

- Losses continue to increase (20%+) due to subsidence and asset base growth
- $350 billion of loss is equivalent to reconstructing New Orleans buildings 6X over, and represents
    - A Katrina-like hurricane becomes a once in every generation event
    - 7% of total capital investment for the Gulf Coast area; 3% of annual GDP
- The impact of severe hurricane in the near-term could also have a significant impact on any growth and reinvestment trajectory in the region.

What's at Stake? (posted at: http://www.futureofthegulfcoast.org/page.php?page_ID=5)
Local Livelihoods & National Assets
The Gulf Coast is home to 21 million people and is expected to grow by more than 15% over the next decade. (*U.S. Census Bureau, 2011a; Woods and Poole Economics, Inc., 2010*)

The five Gulf States account for 17 percent of U.S. Gross Domestic Product. If considered a country, their combined GDP of more than $2.4 trillion would rank as the 7th largest economy in the world. *Bureau of Economic Analysis, 2011*

The Mississippi River's ecosystem services alone are worth $11-47 billion. (*"Gaining Ground. Wetlands, Hurricanes and the Economy: The Value of Restoring the Mississippi River Delta" David Batker, et al.*, posted at:

http://www.eartheconomics.org/FileLibrary/file/Reports/Louisiana/Earth_Economics_Report_on_the_Mississippi_River_Delta_compressed.pdf)

ENERGY

- 54% of U.S. crude oil production
- 52% of U.S. natural gas production
- 47% of U.S. crude refining capability
  U.S. Energy Information Administration, 2010; 2011

The above figures represent energy production and refining capacity of the Gulf of Mexico region as percentages of the total U.S. share. The crude oil and natural gas percentages total the aggregate of federal and state offshore production in the Gulf of Mexico and the entire states of Florida, Alabama, Mississippi, Louisiana, and Texas. Crude oil refining capacity represents the entire states of Florida, Alabama, Mississippi, Louisiana, and Texas. Data is not readily available below the state level.

- $15.6 billion in wages
  Bureau of Labor Statistics, 2010

SEAFOOD

- 1.4 billion pounds in annual commercial fishing landings
- 78% of U.S. Shrimp – 221 million pounds
- 62% of U.S. Oysters – 22 million pounds
- $10.5 billion in sales and $5.6 billion in income
  National Marine Fisheries Service 2008; 2010

SHIPPING

- 2 of the world's largest ports & 6 of the 10 largest ports in the U.S. (by tonnage)
  U.S. Army Corps of Engineers, 2010
- 50% of all U.S. international trade tonnage
  U.S. Army Corps of Engineers, 2010
- 2/3 of all oil and gas imports
  U.S. Global Change Research Program, 2009
- 60% of U.S. grain exports
  USDA Grain Inspection, Packers & Stockyards Administration, 2011

TOURISM

- $20+ billion annually
  Environmental Protection Agency
- 15.2 million beachgoers annually
  National Ocean Service, NOAA, 2000
- 2.2 billion spent on 23 Million recreational fishing trips annually
  National Marine Fisheries Service, 2010
- 600,000+ jobs
  Bureau of Labor Statistics, 2010; Colgan, 2004

ECOSYSTEM SERVICES

- 97% of Gulf of Mexico commercial seafood landings rely on estuaries and wetlands to survive.
  National Oceanic and Atmospheric Administration, 2010
- 75% of North American migratory birds depend estuarine habitats during migration
  Gulf of Mexico Foundation

- 1 acre of wetlands can sequester significant amounts of carbon and store 1.5 million gallons of water, reducing the impact of flooding and storms (The presence of wetlands in only 15% of a watershed can reduce flooding by as much as 6%.)
  United States Department of Agriculture, 2007
- Gulf Coast restoration could create 57,697 jobs over the next decade
  The Walton Family Foundation; Mather Economics, 2012

Entergy has initiated pilot projects in two key areas along the gulf to implement resiliency measures, Port Fourchon in Louisiana and Port Arthur Texas, particularly vulnerable areas that are critical to the national economy. These ports, when combined with other refining capacity in these areas produce 60% of the nation's energy. Four refineries in the area produce 24% of US gasoline and 44% of the nation's LNG import capacity.

Port Fourchon

- Parish elevation ranges from 3 ft to 16 ft
- Serves Louisiana Offshore Oil Port (LOOP) - major port for 13% of oil imported to US; handles 1.2 million barrels per day of oil
- The region is home to over 100,000 people and over 40,000 jobs
- Wetlands in the area support over 400 at-risk species and the livelihoods of commercial fishers
- Economic assets and value at risk in 2030:
  - $6.9 billion of economic assets
  - $1.1 billion of energy related assets
  - $1.8 billion of GDP

Port Arthur

- 1 ft above sea level gradually rising to ≈ 23 ft.
- The port of Beaumont Port Arthur is the 7th busiest in the US
- The Sabine Pass LNG terminal is the largest receiving terminal in the world by re-gasification capacity
- The region is home to approximately 380,000 people and over 296,000 jobs
- Economic assets and value at risk in 2030:
  - $60 billion of economic assets
  - $23.4 billion of energy related assets
  - $12 billion of GDP

A.1.b. Tools available to address the major vulnerabilities

The "Building a Resilient Energy Gulf Coast" Executive Report also identifies and ranks the cost effectiveness of tools available to mitigate risk, those evaluated include resiliency measures on the energy distribution system, sandbags, dedicated levees at strategic industrial locations and areas of dense population, building improvements and retrofits, beach nourishment and barrier island restoration, design specifications for offshore production, and resiliency measures for new homes and retrofits. In table 5 of the Executive Report, these measures are ranked relative to their cost and effectiveness in preventing loss. (*See page 9*)

In interviews, stakeholders consistently noted that measures implemented after prior storms proved to be effective at minimizing damage in subsequent storms, such as hardened transmission facilities, back-up power generation for key facilities and cell phone towers, coordinated communication plans, evacuation planning and communication, storm surge protection measures, and building codes.

Community Development Block Grants have supported some of the resilience work that has been accomplished.

Suggestions coming from these interviews included preventative maintenance, creating a database of qualified industrial electricians who can help restore facilities following a hurricane, and for Louisiana, securing a dependable source of funding for the State Wetlands Restoration Master Plan.

Please also see the Risk Transfer suggestions described in response to question 12 below.

c. policy intervention needed

- Build broader trust and understanding among state, local and federal agencies to solicit comprehensive involvement in planning and project development.
- Develop comprehensive, long-term planning in lieu of reactionary, piecemeal projects and policies.
- Revise U.S. Army Corps of Engineers' valuation methodology so that Gulf oil and gas ports are ranked by tonnage.

Policy makers can and must take a leadership role in driving a coordinated response across individuals and sectors. Policy makers can support and enforce a range of actions to reduce the risks that individuals bear (e.g., through building codes, development decisions). They can also unlock barriers to increasing the resilience of industry (e.g., electric utility and oil and gas sectors).

Resolve Conflicting Federal Policies & Practices

Contradictory rules, regulations and agency priorities impede coastal restoration by delaying projects and increasing costs. A more orderly, efficient process must be established to meet urgent needs.

- Fast-track coastal restoration projects that align with approved plans and priorities by establishing an appropriate mechanism, such as an emergency rule.
- Eliminate conflicting federal policies and improve inter-agency coordination by working with the Gulf Coast Ecosystem Restoration Council and the President's Gulf Coast Ecosystem Restoration Task Force to create a facilitating mechanism or agency structure that streamlines Gulf Coast protection and restoration.
- Clarify mitigation requirements and restructure the permitting process to avoid delays or increased costs for environmentally beneficial coastal projects.
- Consider alternative approaches, such a pooled mitigation funds, to finance priority, systemic projects.
- Unlock the Harbor Maintenance Trust Fund for its intended purpose — navigation channel maintenance — and enact policies that greatly increase the beneficial use of dredge material for coastal restoration.
- Support and expedite efforts by the U.S. Army Corps of Engineers to update their guidelines and principles to more appropriately address coastal restoration.
- Resolve conflicts among the National Flood Insurance Program, Federal Emergency Management Administration, U.S. Army Corps of Engineers, and the Housing and Urban Development Agency, so that uprooted communities can refer to a single, easy-to-understand relocation/"buyout" policy.

Q.2 To what extent is an aging/retiring workforce an issue? What sorts of programs can help address issues that exist?

A.2 Aging/retiring workforce, along with emerging talent needs, is a current challenge for Entergy. Entergy has on-going workforce planning work, but has recently kicked off a system wide effort to focus on some of the key areas/jobs where we are having challenges. Two of these job groups include engineers and skilled craft.

Entergy's initiative to help address these issues identifies strategic workforce planning as an embedded part of the annual and multi-year business planning process and defines the following:

- Ongoing process to identify the workforce needs for the future.
- Identification of the gap between demand and supply for staff
    - workforce numbers,
    - job roles and skills, and
    - the resultant degree of business risk.

Workforce planning is a critical part of corporate planning and a driver for high-impact Talent Management strategy that is closely aligned with senior leadership's strategic vision, through:

- actionable plans to inform business decision-making (action and accountability),
- consistent enterprise structure that will provide workforce planning services and guidance to business units, and
- seamlessly connecting workforce plans to business goals and financial planning.

Strategic Workforce planning includes:

- predictive analysis that results in actionable workforce strategies,
- efforts to ensure future supplies of new employees with the needed knowledge and skills, and
- managing the risk of loss of critical knowledge and skills.

Q.3 Are there ways to strengthen industry/government partnerships around cybersecurity issues, improving flows of information and data that are critical to protecting assets?

A.3. A few suggestions, some of which are already occurring, that help facilitate the sharing of cyber information with owners of critical electrical infrastructure:

- Develop action campaigns to provide classified briefings to private sector critical infrastructure organizations across the country;
- Continue initiatives (i.e. SAFEGUARD and CSET) which assist major electric sector asset owners in proactively understanding their state of security;
- Provide expertise on malicious capabilities and intentions of emerging cyber threat actors targeting the electric sector, including in unclassified forums;
- Continue programs which offer voluntary partnerships with private owners of critical infrastructure; and
- Proactively reach out to and share threat intelligence with private sector assets owners who are the target of active threat campaigns.

Q.4 What are the most critical system interdependencies, and how can stakeholders and policymakers address system weaknesses and vulnerabilities posed by these interdependencies?

A.4.

The oil and gas industry is dependent on electric power, thus service disruption has a major impact on this sector. The concentration of oil and gas infrastructure in the Gulf Coast, coupled with the

vulnerability of this area, and the national dependence on the oil and gas produced creates significant risk to this industry in particular. For more detailed information on oil and gas infrastructure in the Gulf Coast, see the response to question 6 below.

Q.5.A Are there specific policies, or policy gaps, that create vulnerabilities? Could these be addressed through specific executive or legislative action?

A.5.

Policy makers can and must take a leadership role in driving a coordinated response across individuals and sectors. Policy makers can support and enforce a range of actions to reduce the risks that individuals bear (e.g., through building codes, development decisions). They can also unlock barriers to increasing the resilience of industry (e.g., electric utility and oil and gas sectors).

Specific recommendations that would support resilience planning include:

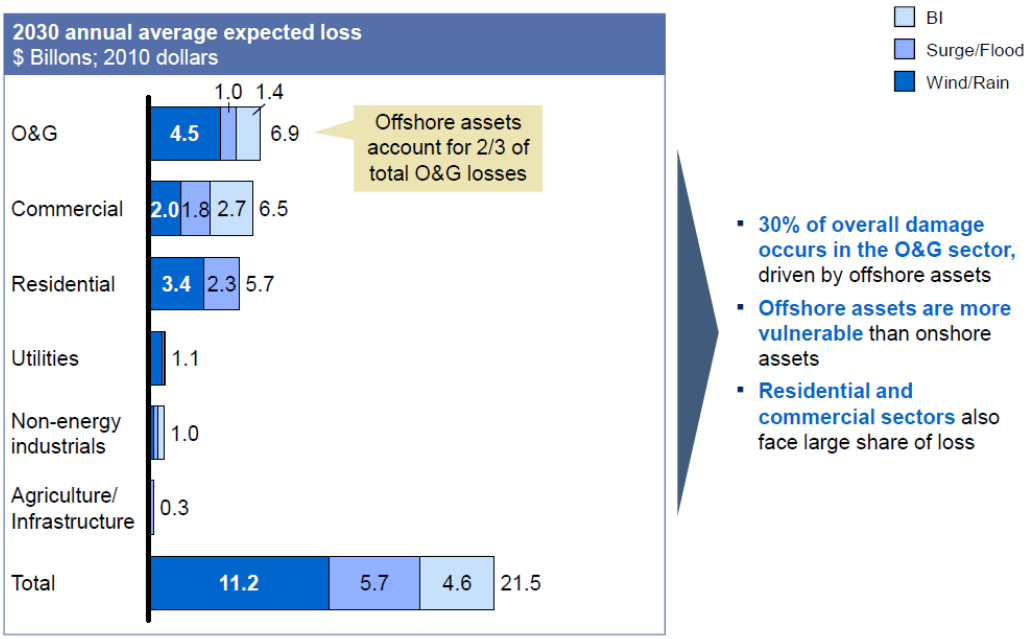
- Facilitation of a sectoral resilience collaborative to discuss energy system needs and best practices, such as the Department of Energy Utility Climate Resilience Partnership kicking off in Noveber (2014).
- Facilitation of a multi-sectoral resilience collaboration to identify how we can adopt resilience Initiatives and investments that compliment what others in the energy value chain are doing to avoid economic loss.
- Researching improved methods for avoiding economic losses from energy system disruptions.
- Having a plan for building resilience and deploying funds for implementing plans, including evaluating the development of ratemaking policies that will allow for recovery of resiliency measures.

Q.6. Are there significant differences in the economic and other impacts of service disruptions to a specific user class (commercial, residential, or industrial) or other (duration, location)?

A.6. There are significant differences in the economic and other impacts of service disruptions to specific user classes, as well as the duration and location of an event.

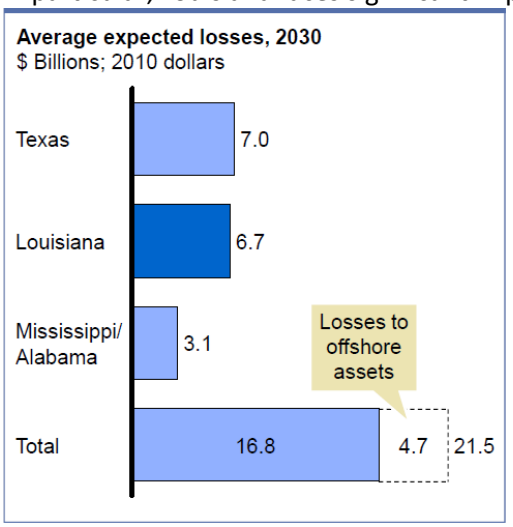
Energy assets in the Gulf Coast -- approximately 50,000 oil and gas structures, including 90,000 miles of pipelines, 2000 offshore platforms and 27,000 wells, over 500,000 miles of T&D, and ~300 generation facilities -- significantly affect the economic impact of service disruptions in this area.

As shown on the table below, among economic sectors, oil and gas assets are particularly vulnerable.



Source: Swiss Re

In particular, Louisiana faces significant impact from climate risks:



Source: Swiss Re; BEA; Moody's

Additionally, Stakeholders participating in interviews with Entergy indicated that for industrial customers, business interruption losses occur during evacuations, stressing the need for good communication regarding evacuation and having business continuity plans in place and coordinated between industries and the utilities serving them.

Q.7 What new information do government and stakeholders need to support a resilient TS&D infrastructure?

The panel participants at the May 27, 2014 QER meeting #3 on petroleum transmission, storage, and distribution issues provided input on the impact to the national economy of the oil and gas infrastructure located in the Gulf Coast, as well as the vulnerability of this area. A broader

understanding of this interdependency among government and stakeholders would likely increase support for resiliency through risk mitigation strategies.

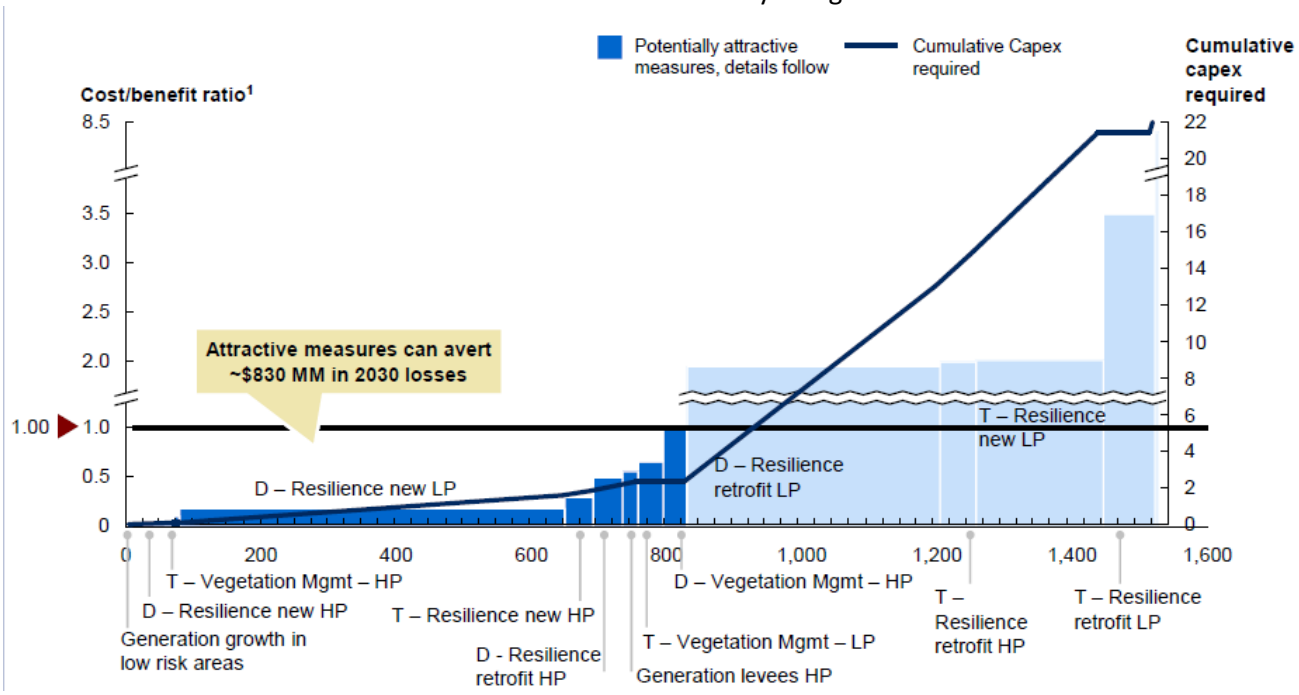
Q.8 How much and what type of investment is needed in energy TS&D to ensure the safe delivery of electricity, natural gas, oil and liquid fuels, given the average age of the systems?

A.8 Investment needed in energy T&D:
Driving a "practical" solution that takes Gulf Coast "resilience" to the next level represents an optimal solution to balance the cost requirements with the risks that impact the Gulf Coast

- Several "no regrets" moves exist for adaptation that have low investment requirements, high reduction of expected losses (regardless of impact of climate change) and additional benefits (e.g., wetlands restoration);
- These investments will avoid "mortgaging our future" with a heavy burden of ineffective actions, which is of utmost importance for the Gulf Coast
- Focus on adaptation in the near term and mitigation for the longer-term
- Industry can and must take a leadership role in driving a coordinated response

Cost beneficial utility measures can address $830 million of loss in 2030:

- Resilient distribution lines (both new builds and retrofits) are key actions
- Vegetation management has potential to reduce losses at a cost to benefit ratio of less than 1.
- Transmission resilience efforts tend to be attractive only in high risk areas.

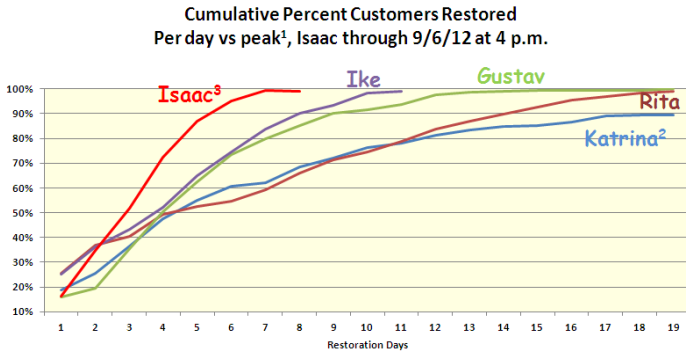


Note: HP refers to High Priority areas (zip codes with high average losses) ; LP refers to Low Priority areas (zip codes low average losses)
1 Benefits include utility property damage + utility business interruption + commercial and non-energy industrial business interruption aversion
Source: Swiss Re

Q.9 What metrics are used to assess current conditions and measure improvements in resilience and security?

A.9 Metrics to assess current conditions and measure improvements in resilience and security.

- In Texas, business losses from prior storms are being calculated for use in protection system studies.
- Reduction in losses from mitigation measures that have already been implemented, for example losses from Hurricane Ike were appreciably smaller due to measures such as building codes, the establishment of base flood elevations, and the installation of back up generation after Hurricane Rita.



[1] *Based on non-coincident system peak*
[2] *Excludes extended restoration customers; Rita 800K start is net of continued Katrina restorations in progress*
[3] *Excludes 1,649 customers projected to be unable to receive service (as of September 6)*

- While Isaac was the fourth worst storm in Entergy's history in terms of outages, the time to get customer service restored was greatly enhanced by our T&D hardening. We found ourselves replacing insulators on transmission towers instead of having to replace the transmission structure itself.
- This graph shows that after it was safe to respond to Isaac in 2012, Entergy had 90% of its customer service restored within five days, a company best. By comparison, it took 17 days to reach the 90% restoration level for Katrina. We recognize that every storm is unique, and this figure doesn't include all of our customers whose homes were flooded and uninhabitable for months after the storm.
- But we believe that much of the strength and resilience of our system today is a direct result of continued investment in our infrastructure and our people, preparedness planning and other efforts to manage risk.

Q.10 How can government and industry accelerate appropriate resilience and security improvements?

A.10 See above suggestions for government action in response to question 5 above and question 12 below.

Q.11 What financial, market or other incentives would encourage investment in resilience and security measures?

Stakeholders participating in interviews with Entergy indicated that a mechanism needs to be available for smoothing out costs to customers for hardening investments, such that upgrades and improvements are planned on a long-term investment cycle.

A.11 Allow innovation and enterprise to flourish by supporting strategies to facilitate Regional Stewardship. Currently, bureaucratic barriers and a lack of smart incentives hinder the development of creative, efficient coastal restoration strategies. Unless policies and plans harness the power of new technologies, visionary research, market forces and local ingenuity, environmental degradation will continue to outpace restoration and protection efforts.

- Determine a method for valuing ecosystem services that can be incorporated into the permitting process, including the development of a consequence/cost ratio to be used as a supplement to traditional cost/benefit project analysis.
- Provide tax credits or other incentives, such as mitigation credits, for private landowners who complete restoration and resiliency projects, such as marsh creation, carbon sequestration and home retrofitting.
- Support funding for living shorelines, such as constructed oyster reefs, which provide multiple benefits, including shoreline protection, water quality improvement and enhanced coastal habitats.
- Develop a viable carbon market through public/private partnerships to create incentives for carbon sequestration, land building and emissions reductions.
- Fund the development of a comprehensive, regional water management and coastal restoration strategy that integrates the Mississippi River watershed and fresh water planning.

Q.12. What steps can be taken to make our energy infrastructure more resilient given demographic shifts to coastal areas prone to extreme weather?

A.12. Steps that can be taken to make our energy infrastructure more resilient in coastal areas prone to extreme weather:

Driving a "practical" solution that takes Gulf Coast "resilience" to the next level represents an optimal solution to balance cost requirements with risks that impact of the Gulf Coast.

- **There are several key "no regrets" options for adaptation** that have low investment needs, high reduction potential of expected losses (regardless of impact of climate change) and additional strong benefits (e.g., wetlands restoration). These investments will avoid "mortgaging our future" with a heavy burden of ineffective actions, which is of utmost importance for the Gulf Coast. In particular, investing approximately $50 billion over the next 20 years in measures with cost-to-benefit ratio less 1 will lead to approximately $135 billion in averted loss over the lifetime of measures. Pursuing all potentially attractive actions may involve an investment of approximately $120 billion over the next 20 years, and may lead to $200 billion in averted loss over the lifetime of measures **listed and described on pages 7 through 10 of the "Building a Resilient Energy Gulf Coast" Executive Report**.
- **There needs to be a focus on adaptation to address near-term risks, and mitigation to address longer-term risks.** In the near-term, significant impacts from climate change may be "locked in," and will require strong action today (actions should begin with low-cost, "no-regrets measures").
- **Policy makers can and must take a leadership role in driving a coordinated response across individuals and sectors.** Policy makers can support and enforce a range of actions to reduce the risks that individuals bear (e.g., through building codes, development decisions). They can also unlock barriers to increasing the resilience of industry (e.g., electric utility and oil and gas sectors).

There are key uncertainties involved in addressing this vulnerability including: (1) the impact of climate change; (2) cost and effectiveness of measures to adapt; and (3) the ability to gain alignment and overcome obstacles

- **There is a long-standing debate around the extent to which climate change will occur, how large the impacts will be and how soon they will be realized**. However, this analysis indicates that irrespective of any impacts from climate change, the Gulf Coast will face increasing loss from subsidence and asset growth. Uncertainties in climate science are addressed by considering a range of scenarios, informed by the best available science. Depending on the scenario annual losses in 2030 will increase by 30-60 per cent over current figures.

- **There are several adaptation measures that can reduce risk (e.g., improved construction codes, restoration of wetlands); however, there is uncertainty related to their economic benefits**. While the costs related to actions are more certain, the benefits (averted losses) are difficult to quantify – and are related to the occurrence and intensity of hurricanes and other extreme weather events.

- **Actions involve a broad set of stakeholders that have conflicting interests, differing timeframes, and varying levels of effectiveness. Benefits from measures are therefore difficult to capture.** For example, measures related to improved construction codes may require new policies to be put in place by local regulators, actions by individual home owners (who may face barriers related to capital needs), and appropriate enforcement.

As shown in the graphic below potential mitigation options have varying degrees of costs and benefits relative to their effectiveness. *(See "Effectively addressing climate risk through adaptation for the Energy Gulf Coast")*

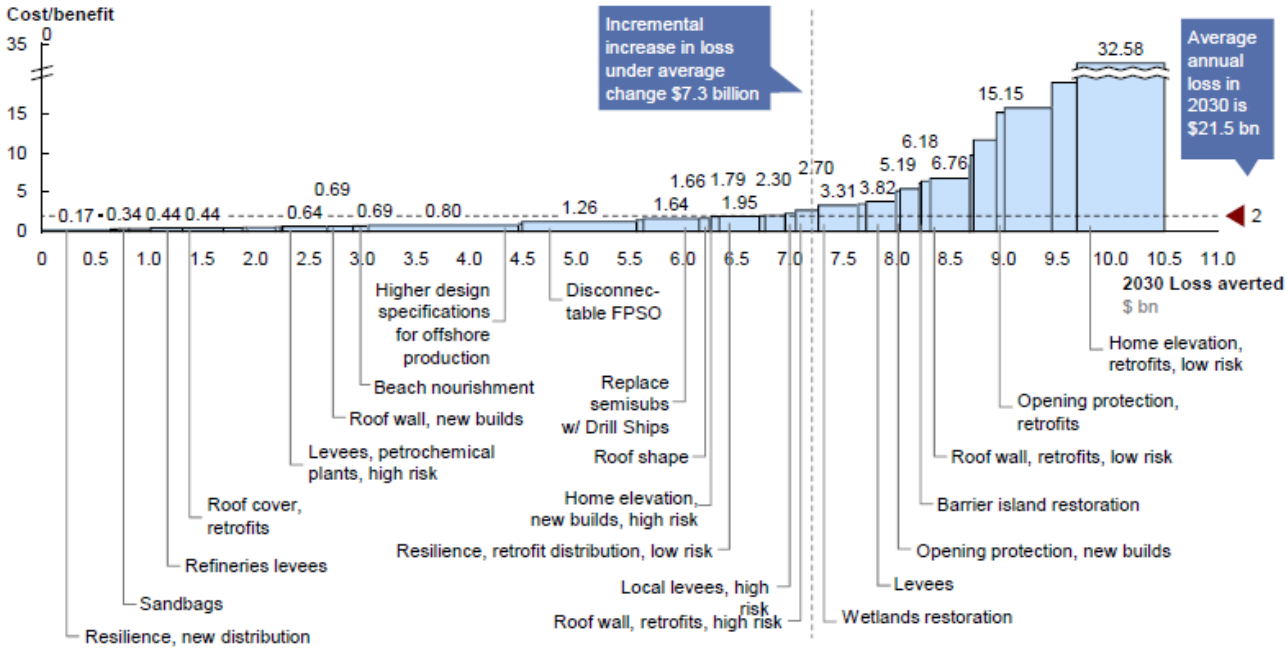
Decrease Regional Vulnerabilities through Cooperative Action

Short-term thinking has led to consequence planning defined by inadequate, piecemeal fixes — mainly in the wake of disasters. The focus must shift to a long-term vision for the future that emphasizes adaptation by using innovative, systemic approaches that incorporate nonstructural and structural elements.

- Address the Gulf Coast as a system with cooperative efforts that emphasize a comprehensive approach beyond geographic or political boundaries.
- Ensure that all levels of government enact policies and set funding priorities that support the maintenance and security of critical at-risk coastal infrastructure.
- Establish a local financial capacity to act by blending reliable, long-term funding streams, such as a percentage of occupancy and property taxes, dedicated to coastal restoration and protection.
- Secure a stable, sustained dredging budget for the U.S. Army Corps of Engineers that includes an additional 15 percent for the transportation and distribution of dredged material for coastal restoration.
- Consider amending federal policies so that urgent coastal restoration projects can be accomplished using the best available technologies to avoid unnecessary delays, cost overruns and capacity issues.
- Modify U.S. Army Corps of Engineers' policies and practices to utilize dredging resources continuously and to prioritize the assignment of necessary equipment and material to critical areas.

- Determine the best method for beneficial retrieval and reuse of Mississippi River sediments during high water periods.

Potentially attractive measures can address the increase in annual loss between today and 2030 and keep the risk profile of the region constant



However, even after the measures are put in place, there is still residual risk to address, especially related to tail risk events. *(See "Effectively addressing climate risk through adaptation for the Energy Gulf Coast")*

Regardless of climate change, the region will face more risk. Asset growth and subsidence will increase loss by ~30% over the next 20 years. With climate change we should expect a Katrina/Rita-type year occurring once every lifetime by 2030. Offshore assets make up 20% of expected loss in the region. Louisiana faces significant risk, with ~12 % of capital investment being "locked in" towards rebuilding each year, and in the Gulf Coast generally, growth is occurring disproportionately in some of the most at-risk areas.

Risk transfer may be more cost efficient than physical measures in providing financial coverage for low frequency events. Potential actions to transfer risk include:

- **Increasing coverage by decreasing risk**
  - Implementing other measures will decrease the expected loss, lowering premiums and increasing the affordability of insurance.
- **Decreasing the prevalence of underinsurance**
  - Providing incentives to update the insured value of homes will prevent asset appreciation from decreasing insurance penetration.

- **Enhancing self-insuring low-value, high-frequency risks**
    - For large entities, self-insurance may be more cost effective than purchasing insurance
- **Transferring top-layer risk**
    - Catastrophe bonds or reinsurance can effectively transfer risk for high-value, low-frequency risks

***Source**: Swiss Re; Wharton Project on Managing and Finance; Sigma database; expert interviews*

Q.13 What are the key technology RD&D needs for risk mitigation, preparedness, recovery and response in the energy TS&D sector?

A.13. As mentioned in response to question number 12 above, there are several key "no regrets" options for adaptation that have low investment needs, high reduction potential of expected losses (regardless of impact of climate change) and additional strong benefits (e.g., wetlands restoration). In particular,

- investing approximately $50 billion over the next 20 years in measures with cost-to-benefit ratio less 1 will lead to approximately $135 billion in averted loss over the lifetime of measures.
- Pursuing all potentially attractive actions may involve an investment of approximately $120 billion over the next 20 years, and may lead to $200 billion in averted loss over the lifetime of measures

No Regrets Options are outlined on pages 7-10 in the "Building a Resilient Energy Gulf Coast Executive report, available at:
http://www.entergy.com/content/our_community/environment/GulfCoastAdaptation/Building_a_Resilient_Gulf_Coast.pdf

Q.14. How is climate change affecting particular components of our energy infrastructure? Which climate trends (e.g., sea level rise; increased risk of drought, flooding, storms, etc.) pose the greatest threat to our energy infrastructure? What are examples of costs and inefficiencies caused by climate change?

A.14. Regardless of climate change, the Gulf Coast faces increase in risks from natural hazards. ~50% of increase in loss by 2030 is unrelated to climate change. Increasing loss is primarily driven by asset growth in the region.

Relative to the particular risks to the gulf coast region:

- **Wind**
    - Damage can occur across the Gulf Coast region and in areas further inland.
    - Potential increase in wind speed of 1.4-2.9% in 2030 (2.1 - 10.2% in 2100) due to warmer sea surface temperatures.
- **Gradual sea level rise**
    - The key risk is along the coastline.
    - Based on Vermeer and Rahmstorf "Global sea level linked to global temperature" (2009), relative sea level may rise by 5-6 inches in 2030 (2.5 - 5 feet by 2100).
- **Storm surge**
    - This risk is along the coastline, linked to hurricane events.
    - Storms can increase the impact of even modest levels of sea level rise.
    - Climate change could lead to more frequent/severe flooding of coastal zones.

In addition to the climate trends identified in this question, Environmental threats in the gulf coast also include:

- **Subsidence**
    - The Louisiana gulf coast is already experiencing significant deltaic land loss and subsidence.
    - Estimates for subsidence vary significantly along the coastline; e.g., 8-31 inches per century.
- **Salt water intrusion**.

Current policy and market forces are shifting the nation's electricity supply's fuel mix. Traditional base load resources such as coal and nuclear power, which have on site fuel storage capabilities, are challenged by both policy and market forces. An increased reliance on intermittent renewables and / or pipeline constrained natural gas can present reliability challenges in certain regions. This was made evident during Superstorm Sandy, when a region with a high dependence on natural gas saw massive increase in natural gas demand for heating and spot prices soared. In many wholesale power markets there is little to no pricing mechanism that takes into account the different values of the various fuel sources, including on-site fuel storage, environmentally clean output, etc.

In April of 2009, Entergy contracted with ICF to provide an analysis of the impacts of hurricanes on the energy sector and national economy. The study was initiated as an input for Storm Hardening of transmission facilities for Entergy.

The Entergy utility system serves a number of important energy facilities.

- LOOP and other Import Terminals: The Louisiana Offshore Oil Port is the only port in the U.S. capable of offloading deep-draft tankers. About 1.2 million barrels per day are imported through LOOP – about 10% of total crude oil imports. In addition to LOOP, Entergy serves other major oil import terminals such as Port Arthur and Lake Charles.
- Petroleum Refineries: About 40% of America's refining capacity is located on the Gulf Coast. About 25% of capacity, including 7 of the 20 largest refineries, is located on the Entergy transmission system.
- Crude Oil and Refined Product Pipelines: Major pipelines deliver crude oil and petroleum products from and through Entergy's region to refineries and markets in the Southeast, Northeast, and Midwest.
- Strategic Petroleum Reserves: Three of four SPR sites are served by the Entergy system.

Given the impact to the national economy, and the costs associated with implementing storm hardening strategies, mechanisms must be developed for appropriate allocation of costs among beneficiaries of these projects, rather than being assigned to customer rates in the Gulf South Region.

Scientists predict climate change will produce more frequent and ferocious hurricanes
Hurricane experience in 2005 and 2008 provide an insight into the physical risks and financial implications

Significant cost impacts ($2006)

- Natural Gas $16.5 B (Katrina & Rita); $6.0 B (Gustav & Ike)
- Oil $12.0 B (Katrina & Rita); $4.6 B (Gustav & Ike)
- Electricity $30.0 B (Katrina & Rita); $15.1B (Gustav & Ike)

Economic Impacts – Economy-wide
Lost Employment (000's of jobs)

- 2005 (500 – 700)
- 2008 (100 – 400)

Lost GDP (%)

- 2005 (0.40 – 0.51)
- 2008 (0.08 – 0.27)

Gulf Coast Refining Capacity shut down (MMBD = Million Barrels per Day)

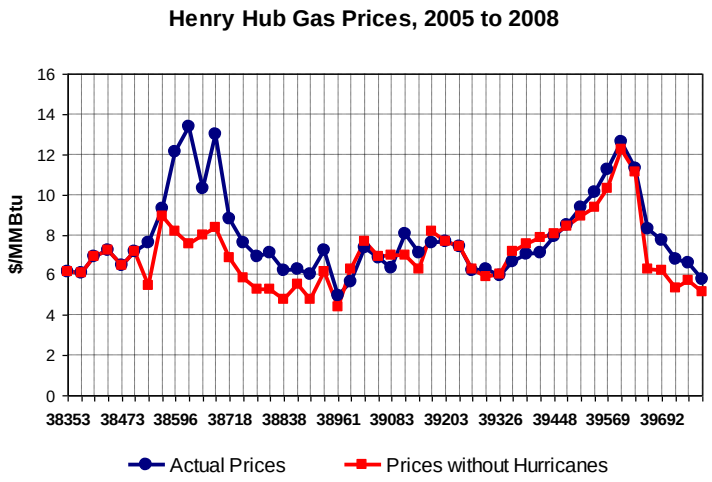
- Katrina 2.5 MMBD
- Rita 4.9 MMBD
- Gustav 2.7 MMBD
- Ike 3.9 MMBD

Energy Infrastructure affected by power outages

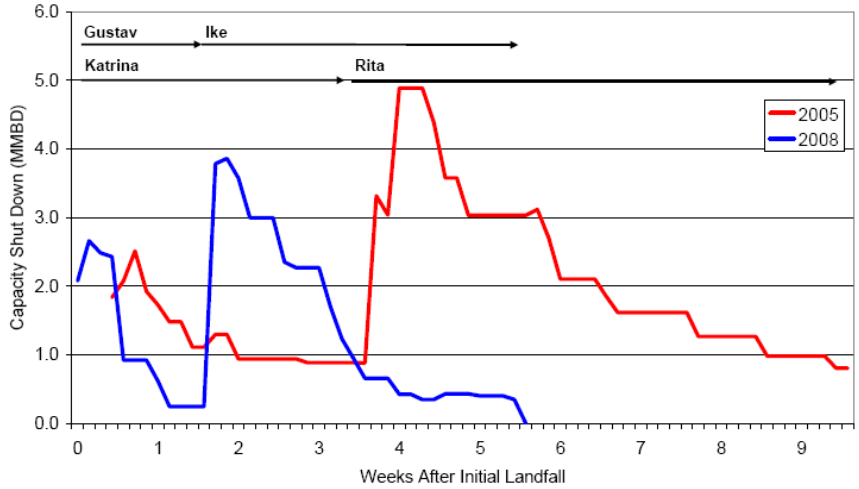
- 18 refineries up to 43 days without power (Katrina)
- 3 pipelines up to 19 days without power (Rita)
- LOOP up to 22 days without power (Gustav)
- Strategic Petroleum Reserve up to 10 days without power (Rita)

The following charts and graphs illustrate the impact of these assets on the national economy:

Natural Gas Comparison With and without hurricane impacts:



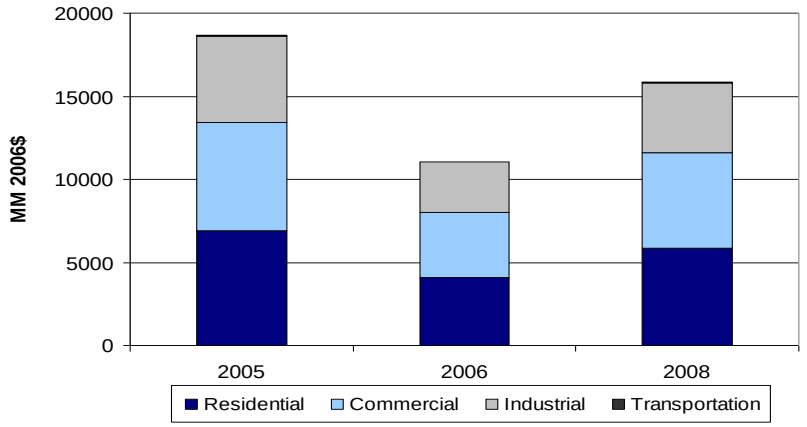
Hurricane Impact on U.S. Gulf Coast Refinery Capacity



Source: OE/ISER Situation Reports.

Electricity Consumer Cost

Hurricane-Related Increase in Cost to End-Use Consumers by Sector (U.S.)



Electricity Consumer Cost

Hurricane-Related Increase in Cost to End-Use Consumers