Determining the Economic Value of Coastal Preservation and Restoration on Critical Energy Infrastructure

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Introduction

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What is Infrastructure?

- Historically thought of as “public works”
- INCLUDES: Pipelines, processing facilities, power plants, power transmission and distribution lines, water and sewer lines, telecommunications, in some minerals production, etc.
- Strongly associated with utilities and the energy business.
- In many instances, either regulated, municipalized, or nationalized outside of the U.S.

What Changed?

- Growing threat from terrorism led to concerns over “critical systems”
- Major electrical outages (1999 and 2003), and the 2005 tropical season led to an increased concern over outages created by human error/coordination failure and natural disasters.

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Critical Energy Infrastructure Components

Energy infrastructure spans and supports a wide range of activities.


















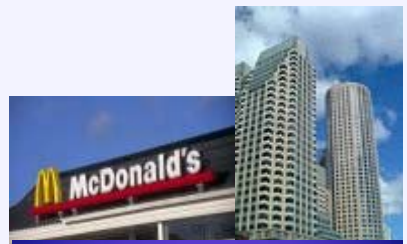

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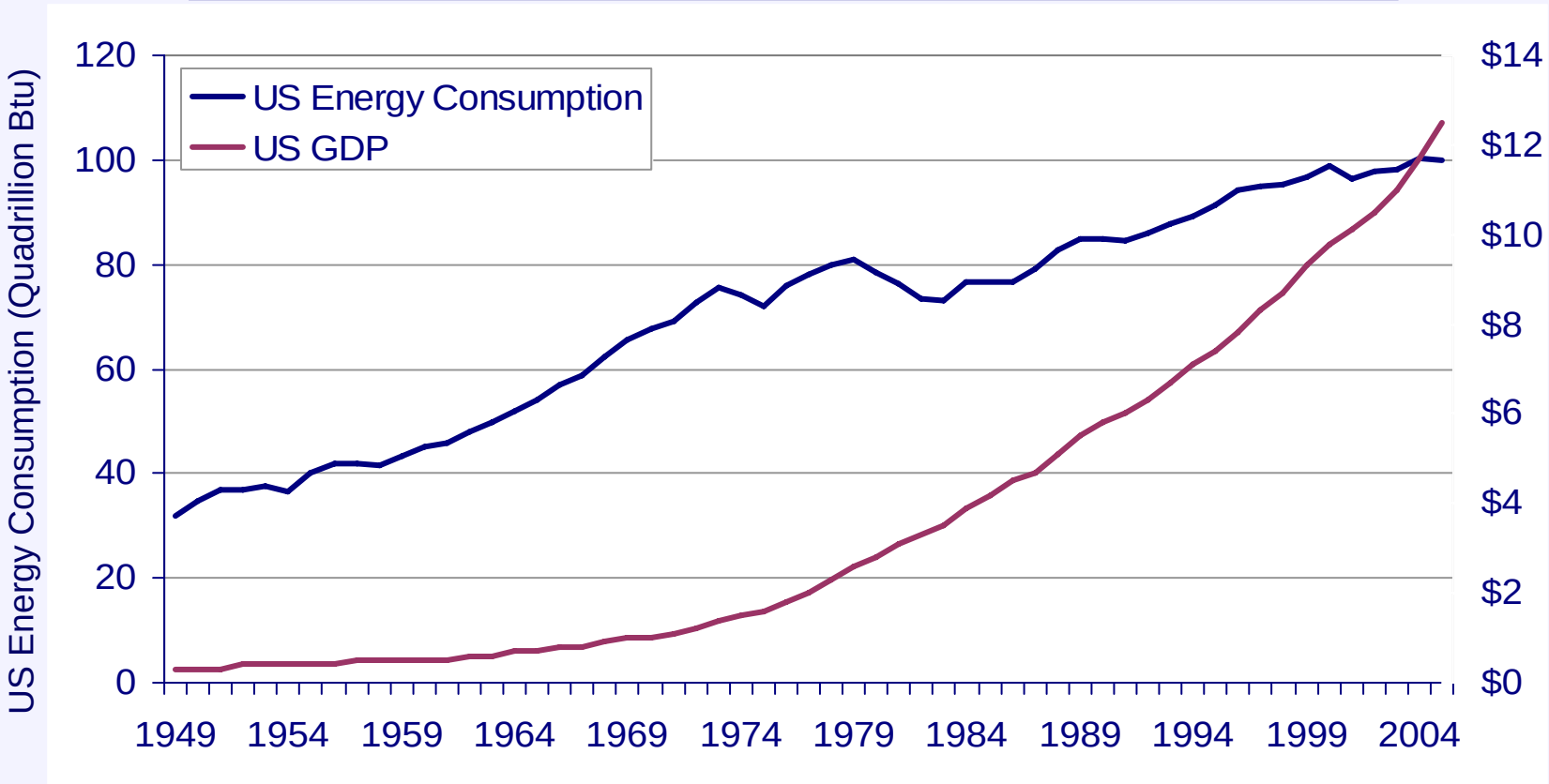
Energy and Economic Growth

As energy use increases, production and economic growth increase



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Concentration of Critical Energy Infrastructure in Coastal Regions

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The Importance of the Gulf of Mexico

- 30 percent total domestic crude oil production
- 20 percent total domestic natural gas production
- Over $6 billion in federal royalties and fees
- 45 percent of total U.S. refining capacity (62 percent east of the Rockies)
- 60 percent of total crude imports
- 43 percent of the Strategic Petroleum Reserve storage capability.
- The largest natural gas users in the world (LA's industrial and power generation use as large as China)

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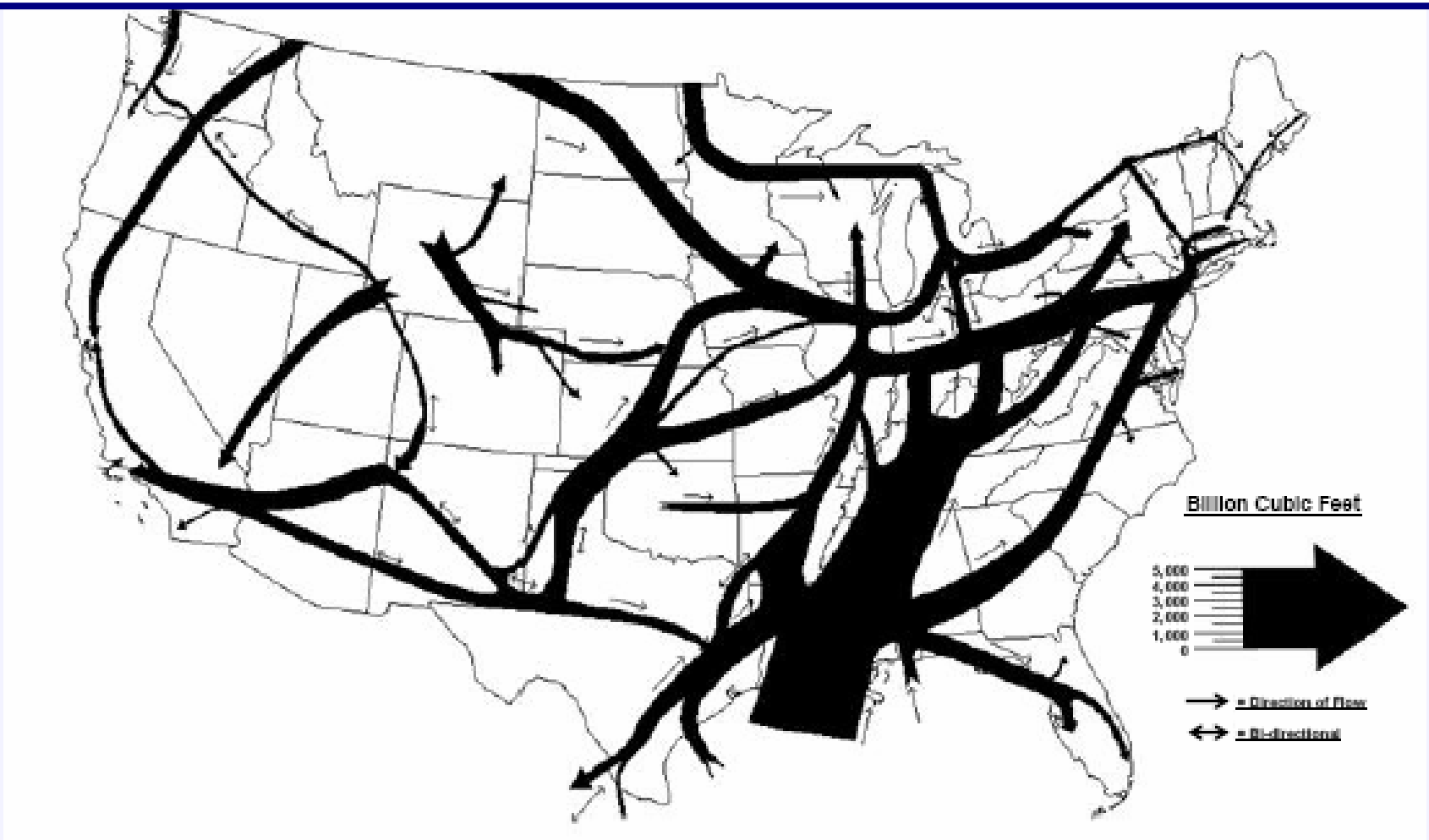
Principle Interstate Natural Gas Flow Summary, 2004

GOM: "aorta" of the U.S. natural gas circulatory system



Source: Energy Information Administration, US Department of Energy

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Recent Experiences with Catastrophic Outages in Coastal Areas:

2005 Tropical Season

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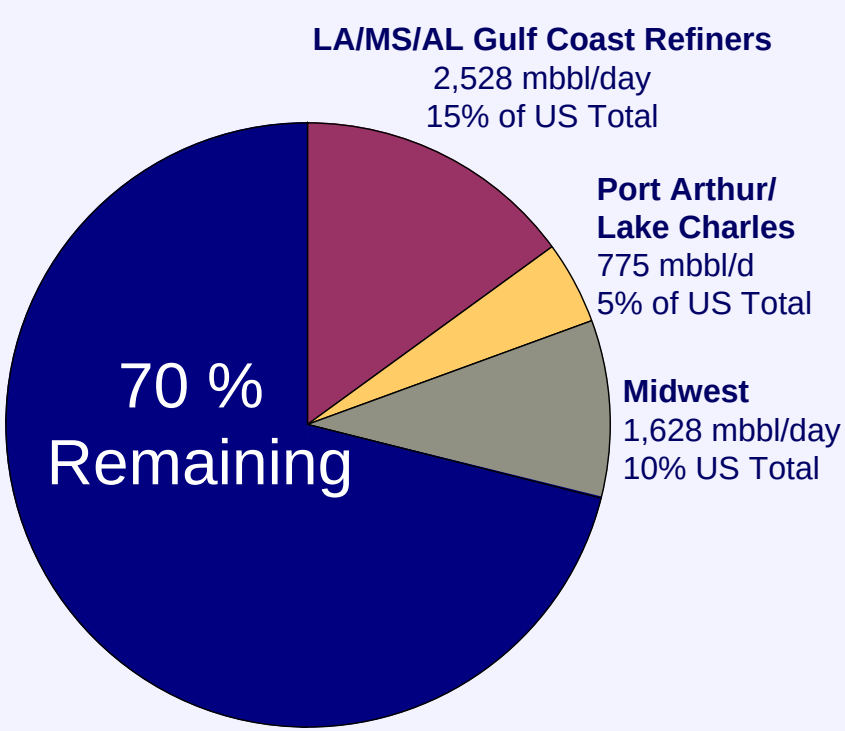
Total Immediate Refinery Impact

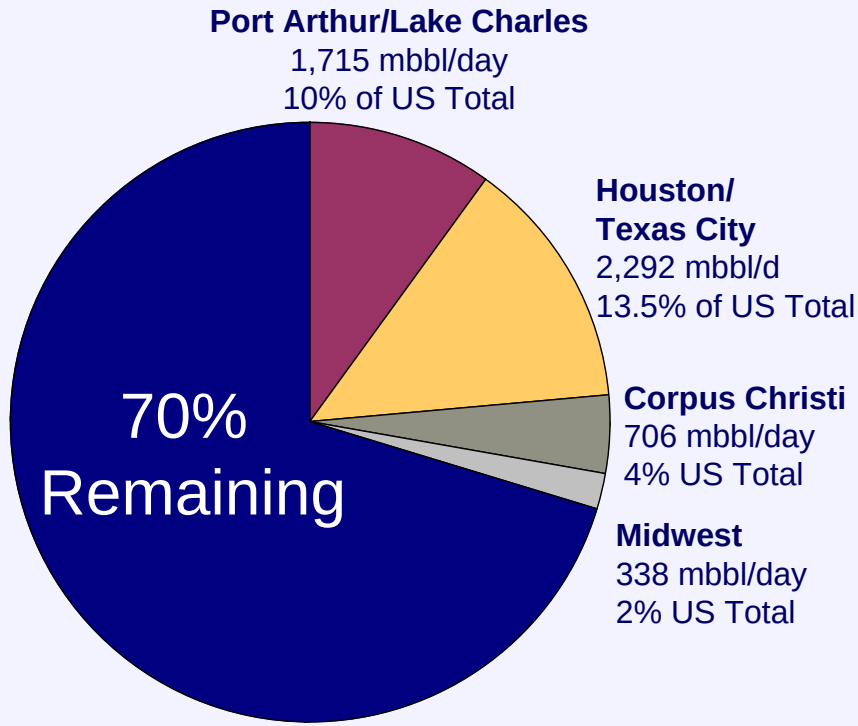
Hurricane Katrina:

Total Refinery Impact
4.9 Million Barrels per Day
(30% US Total)



Hurricane Rita:

Total Refinery Impact
5.0 Million Barrels per Day
(30% US Total)



Source: Energy Information Administration, Department of Energy

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What Do Hurricanes Have to Do with Coastal Erosion?

- Numerous rivers, bays, estuaries, rivers, creeks, and bogs
- Infrastructure typically located near these water bodies (a) taking advantage of their transportation opportunities (b) being geographically unavoidable.
- Many think of wind as being the significant negative impact of hurricanes
- Flooding and storm surge can be significant
- Relationship between coastal erosion and storm surge impacts not clear
- Potential relationship could have significant energy infrastructure implications

State of Existing Literature

Existing Literature

- Little academic/empirical work exists on impact of coastal erosion on energy infrastructure
- Industry recognizes these changes and their importance, particularly from an environmental studies perspective
- Some recognition of the role of disasters
- Focus of literature is on catastrophic, man-made outages/impacts

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Richardson/Scott Study: Economic Impact of Energy Production Outage

Economic Impact: Three Week Oil Production Outage

	Lost Sales --- (million $) ---	Lost Earnings	Lost Employment
Continental US	$ 3,676.1	$ 1,035.6	32,390
Eastern US	$ 2,497.7	$ 702.0	23,344
Western US	$ 344.5	$ 99.6	3,026
Louisiana	$ 68.2	$ 19.9	831

Economic Impact: Three Week Natural Gas Outage

	Lost Sales --- (million $) ---	Lost Earnings	Lost Employment
Continental US	$ 1,803.1	$ 455.2	12,897
Eastern US	$ 1,257.3	$ 316.4	9,049
Western US	$ 198.6	$ 48.4	1,290
Louisiana	$ 57.4	$ 12.9	491

Combined Potential Impact:

Over $4.5 Billion in Sales

Over 45,000 Jobs

Proposed Methods

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What Steps are Need to Accurately Estimate Coastal Erosion Impacts

Impacts

- Gradual/ ongoing impacts
- Catastrophic impacts.

Methods

1. Identify impacted infrastructure – physical assets and physical problems
2. Identify types of impacts – ongoing versus catastrophic.
3. Identify types of costs –
   i. Increased O&M, increased investment costs due to exposure to coastal elements.
   ii. Potential increase incidents of accidents (i.e., spills, injury).

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Erosion – Background

Data on coastal erosion was obtained from a study conducted by the National Wetland Research Center (U.S. Department of the Interior, U.S. Geological Survey, 2003) in Lafayette, Louisiana. Relevant results include:

- **Louisiana lost approximately 1,900 square miles of coastal land from 1932 to 2000.**
- **Louisiana is projected to lose approximately 700 square miles between 2000 and 2050 (absent restoration efforts).**
- **These projections account for the erosion of one-third of coastal Louisiana.**
- **Land loss rates from 1956 through 1978 were 39 square miles per year.**
- **Land loss rates from 1990 through 2000 were 24 square miles per year.**

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Number of Facilities at Risk

Wide number of assets that are exposed to coastal erosion at all levels.

	Intersecting With			Near Projected Land Loss		Within Surge Innundation Zone	
	Historical Loss	Swamp/ Marsh	Projected Loss	1/4 mile	1/2 mile	Katrina	Rita
Refineries	-	4	-	-	-	1	-
Pipelines	819	1,696	347	n/a	n/a	332	1,401
Petrochemical	-	9	-	-	2	4	4
Gas Processing	-	2	-	-	-	1	-
Total	**819**	**1,711**	**347**	**-**	**2**	**338**	**1,405**

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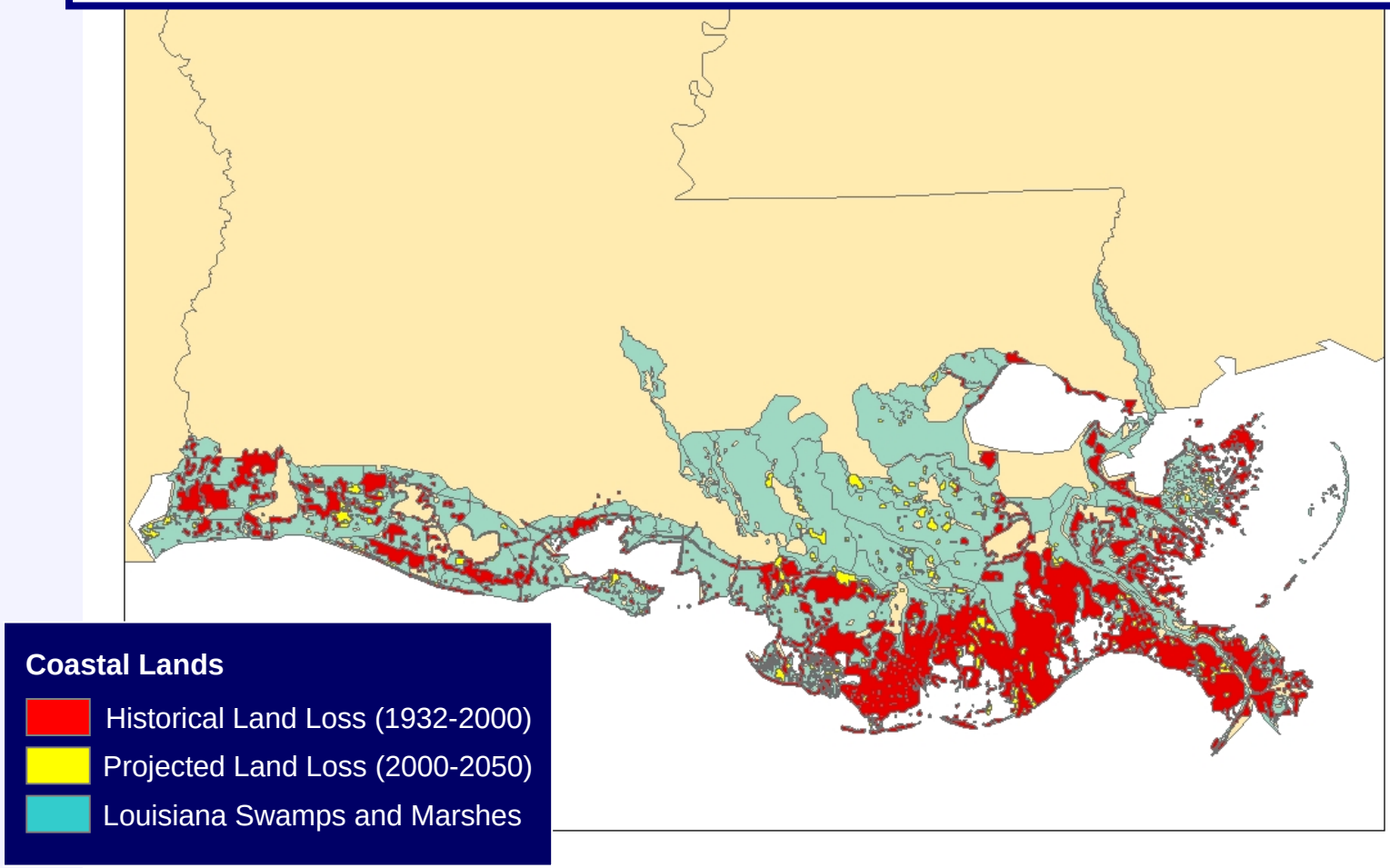
Land Types: Coast of Louisiana

Significant areas of South Louisiana exposed to coastal erosion.



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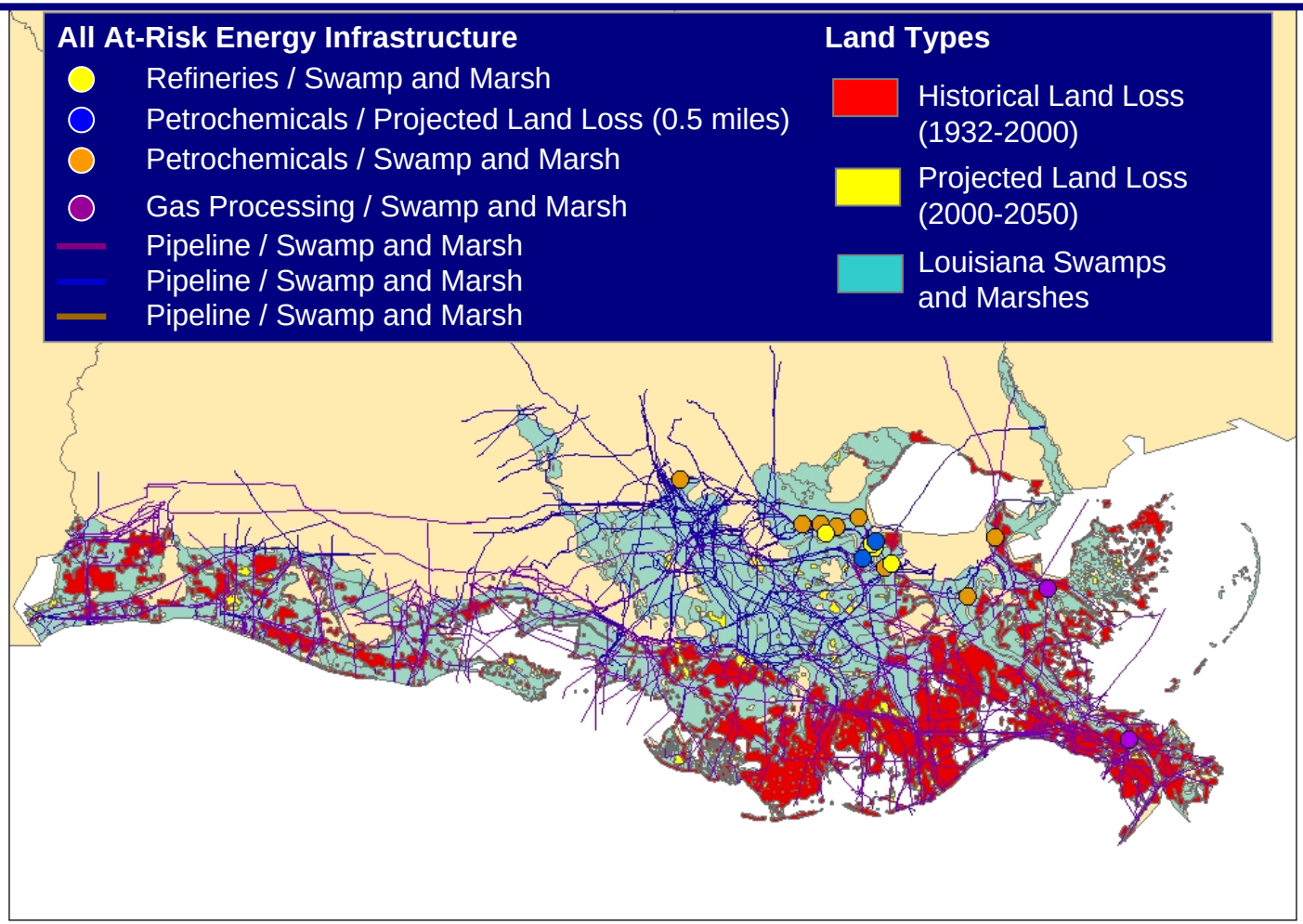
The Louisiana Coast and All Infrastructure

Dispersion of assets across coastal areas that are becoming increasingly more exposed to the coast and water bodies.



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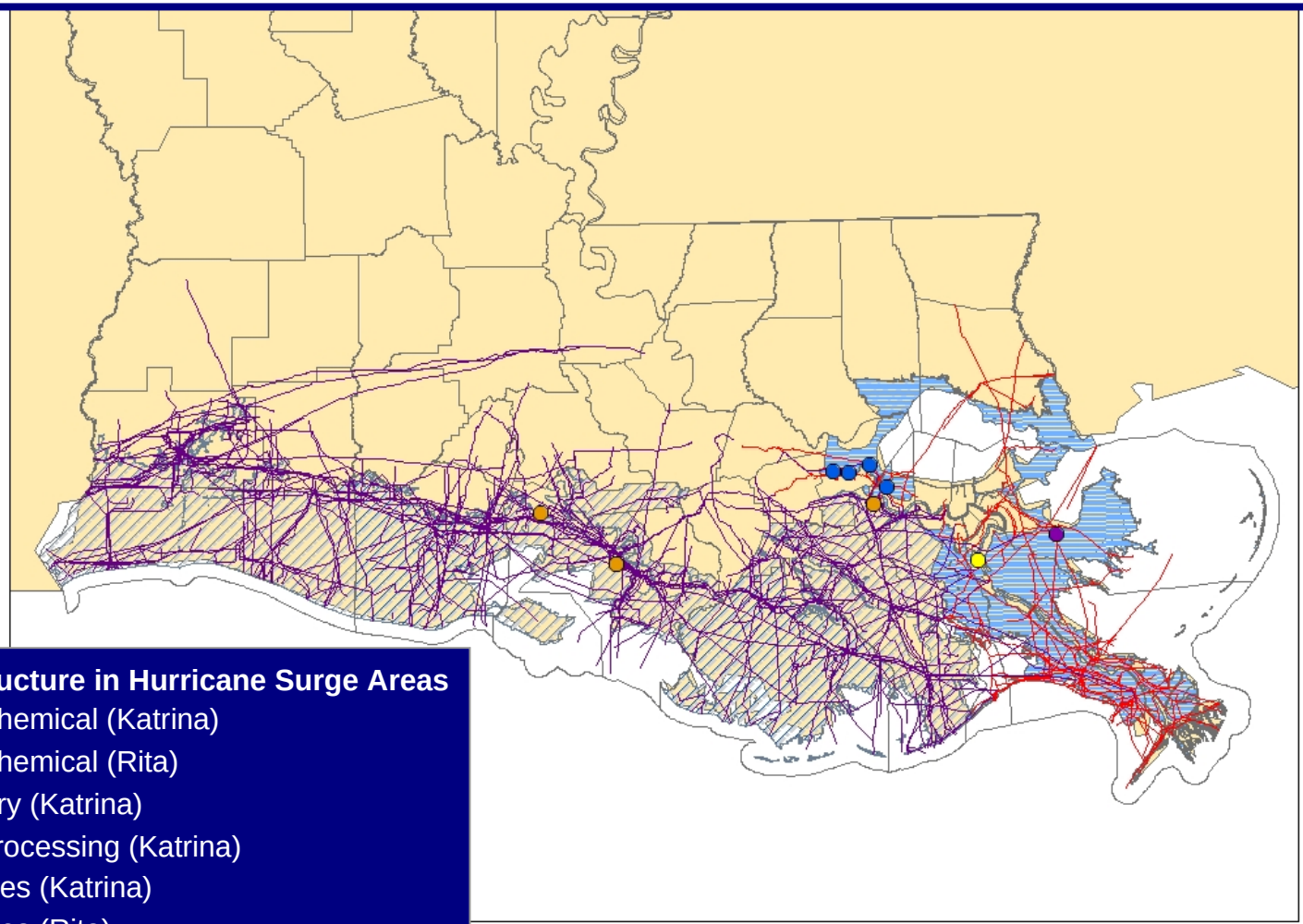
All Infrastructure in Katrina/ Rita Surge Inundation Zones

Surge levels can also expose assets to natural elements.



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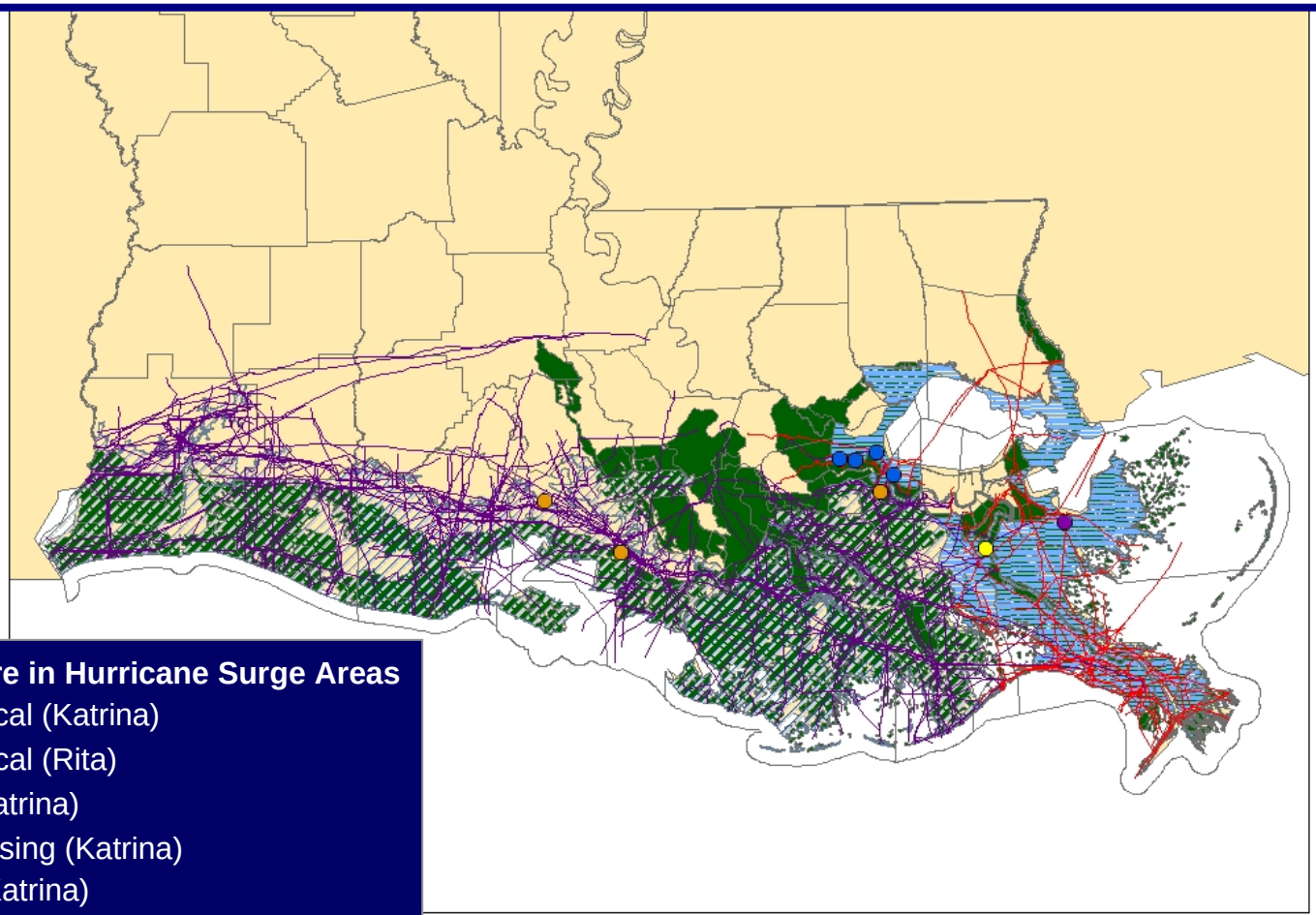
All Infrastructure in Katrina/Rita Surge Inundation Zones with Marsh Overlay

Combined consideration of erosion, storm, and water proximity shows wide range of potential exposure.



All Infrastructure in Hurricane Surge Areas

- Petrochemical (Katrina)
- Petrochemical (Rita)
- Refinery (Katrina)
- Gas Processing (Katrina)
- Pipelines (Katrina)
- Pipelines (Rita)

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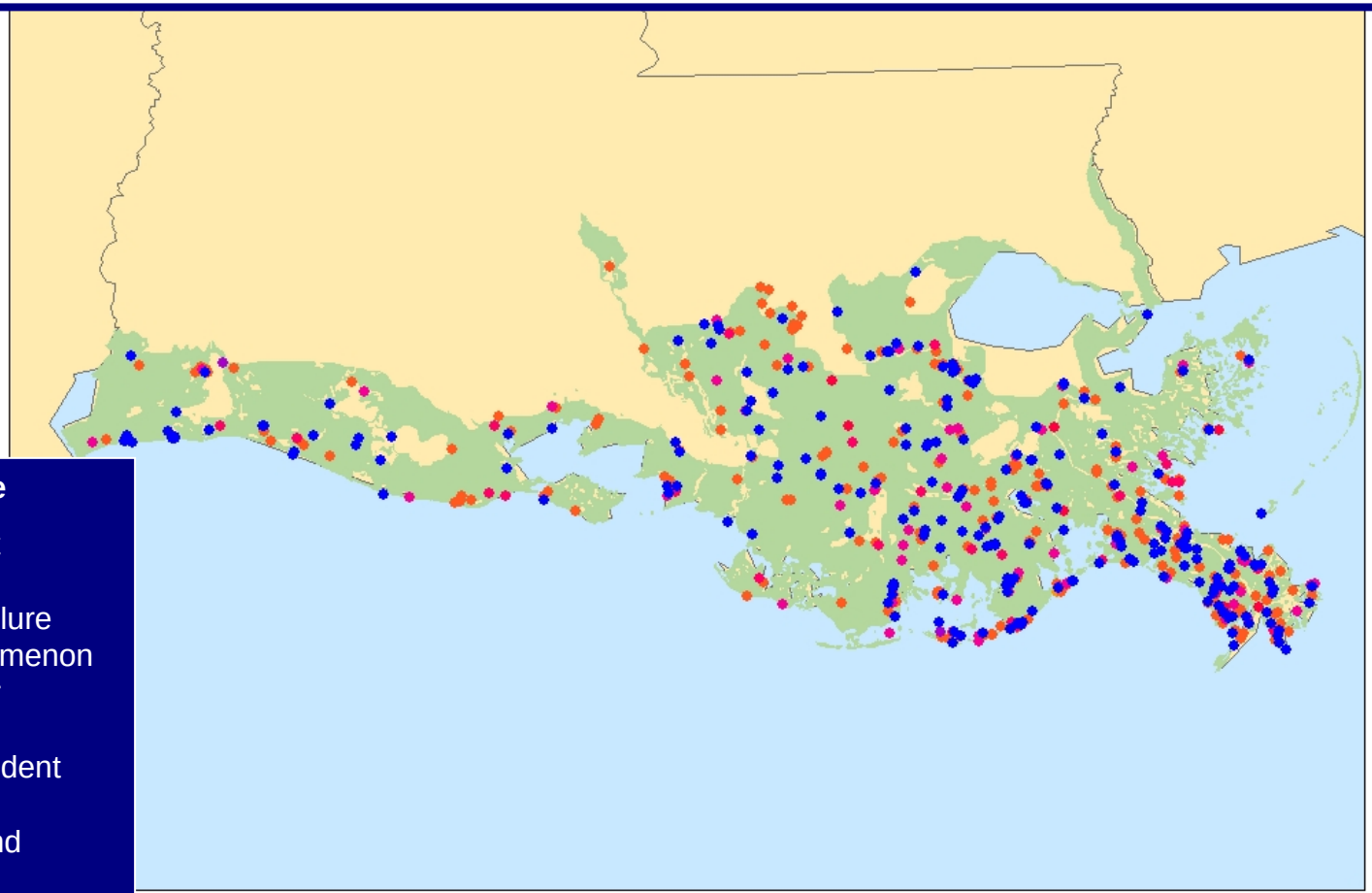
Causes Coastal Pipeline Ruptures Historical and Projected Land Loss

While causality cannot be ascribed directly to coastal erosion, numerous pipeline ruptures due to “unknown” and “natural phenomenon” in coastal risk areas.



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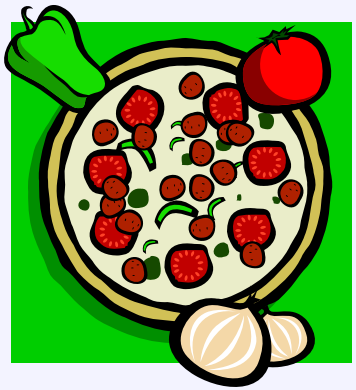
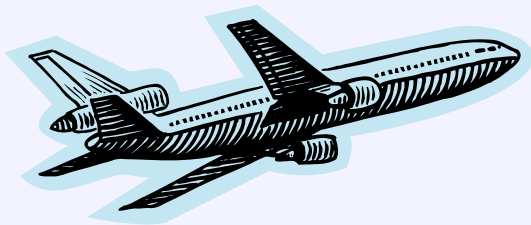
Magnitude of Energy Infrastructure Outages

In one month, lost production from a typical refinery would have….



… delivered over 504 million pizzas

… fueled all the cars in Rhode Island for over 4 months



… fueled about 14,500 commercial airline trips from New York to Los Angeles

… heated almost half of the homes in New England for a month

Note: Assumes a refinery with 250 thousand barrels per day of operating capacity.
Source: Energy Information Administration, US Department of Energy; and various tradepress and company news releases.

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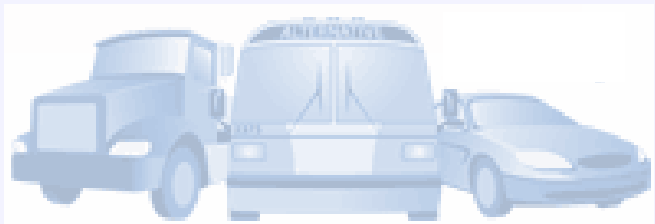
Magnitude of Energy Infrastructure Outages

In one month, lost production from a typical natural gas processing facility would have….

... supplied almost all of the natural gas-fired electric generators in Louisiana and Alabama combined (for the month)

… fueled all the residential users in Michigan (for the month)



... supplied all US natural gas fueled vehicles for well over one year

Note: Assumes a processing facility of 1 Bcf per day of operating capacity.
Source: Energy Information Administration, US Department of Energy; and various tradepress and company news releases.

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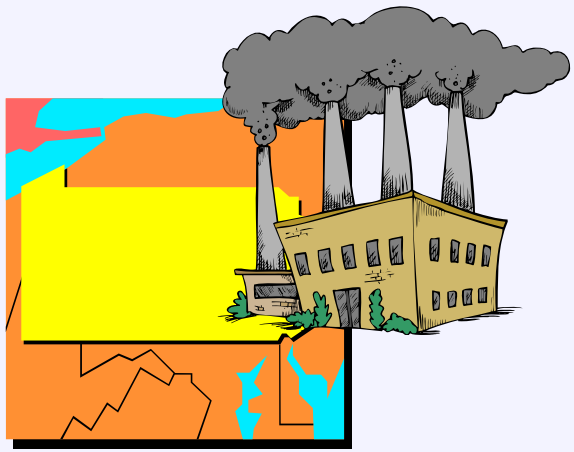
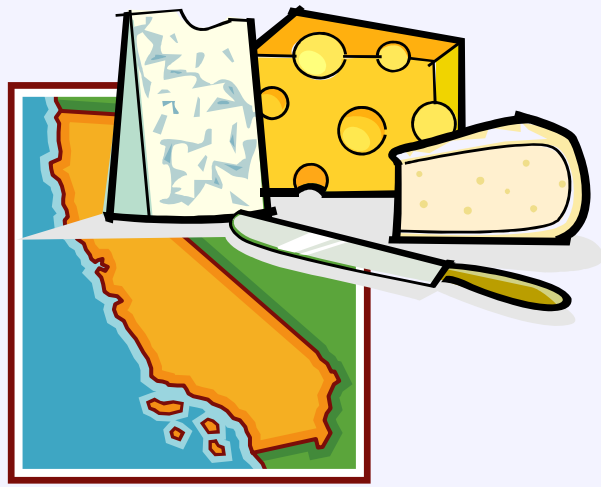
Magnitude of Energy Infrastructure Outages

In one month, lost capacity from a typical major natural gas pipeline would have….

... supplied all of the natural gas-fired electric generators in Arkansas and Mississippi combined (for the month)



... fueled all the industrial users in Pennsylvania (for the month)



... supplied all California cheese makers for three and a half years (California produces over 2 billion pounds of cheese each year)

Note: Assumes a pipeline capacity of 0.5 Bcf per day.
Source: Energy Information Administration, US Department of Energy; and various tradepress and company news releases.

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Conclusions

The valuation of energy infrastructure should be based upon:

- **avoided cost of increased exposure to coastal elements**
- **avoided incremental cost associated with catastrophic coastal events.**
- **avoided cost of safety and environmental incidents.**

- **Value of assets are area-specific. We cannot generalize.**
- **To estimate values industry must work with coastal restoration groups, as well as federal and state agencies, to identify avoided costs.**

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Questions, Comments, & Discussion

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