



# QUADRENNIAL ENERGY REVIEW

ENERGY TRANSMISSION, STORAGE, AND DISTRIBUTION INFRASTRUCTURE

**Briefing for PCAST- May 15, 2015**



# Fundamental Changes in the U.S. Energy Sector

## Increasing Energy Production

- ↘ Natural gas production growth
- ↘ Oil production growth
- ↘ Intermittent renewables
- ↘ Distributed generation/energy resources
- ↘ Increased generation/production/demand efficiency

## Policy Developments

- ↘ CAFE
- ↘ Clean Air Act -111 (d), other
- ↘ Clean Water Act/other
- ↘ RFS
- ↘ RPS (state)
- ↘ RGGI (regional)

## Technology Advances

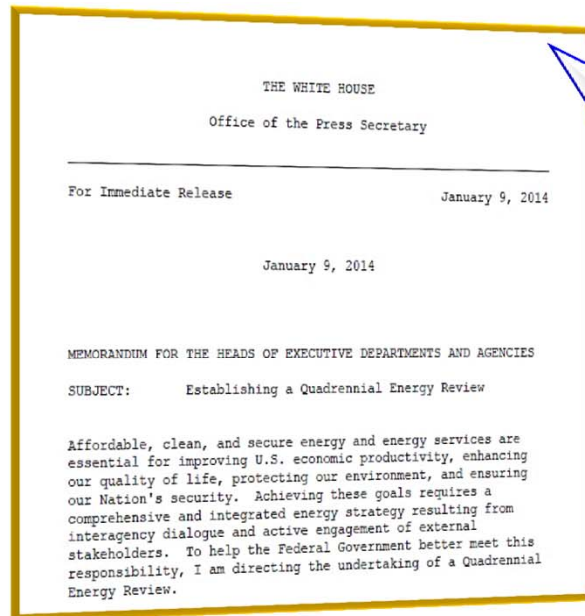
- ↘ Solar (central and rooftop)
- ↘ Wind
- ↘ Demand-side
- ↘ Hydraulic fracturing

## Energy Security Changes

- Decreased N. American energy imports
- Climate change impacts
- Vulnerabilities more evident, including aging infrastructures, physical and cyber threats
- Increased interdependencies
- Increased energy support required by allies



# PM ON THE QUADRENNIAL ENERGY REVIEW



“Affordable, clean, and secure energy and energy services are essential for improving U.S. economic productivity, enhancing our quality of life, protecting our environment, and ensuring our Nation's security.

**Achieving these goals requires a comprehensive and integrated energy strategy** resulting from interagency dialogue and active engagement of external stakeholders.

To help the Federal Government better meet this responsibility, **I am directing the undertaking of a Quadrennial Energy Review.”**

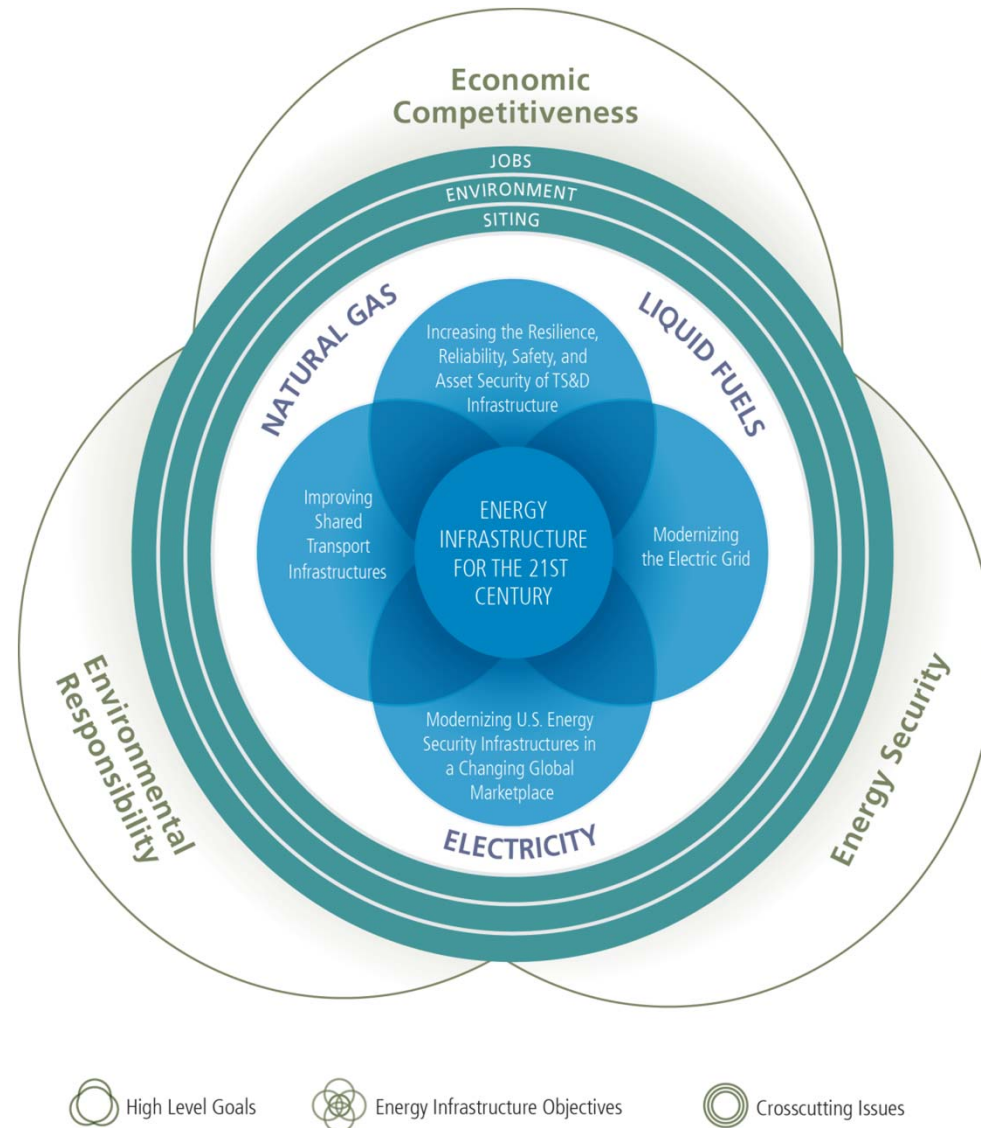
*President Barack Obama  
January 9, 2014*

- **Integrated view** of short, intermediate, long-term objectives for Federal energy policy;
- **Outline of legislative** proposals to Congress;
- **Executive actions** (programmatic, regulatory, fiscal, etc.) across multiple agencies;
- **Resource requirements** for RD&D and incentive programs; and
- **Strong analytical base** for decision-making.
- **First year focus** on TS&D infrastructure including: electricity transmission and distribution systems, liquid and gas pipelines, export infrastructure; interdependencies; climate and environment.



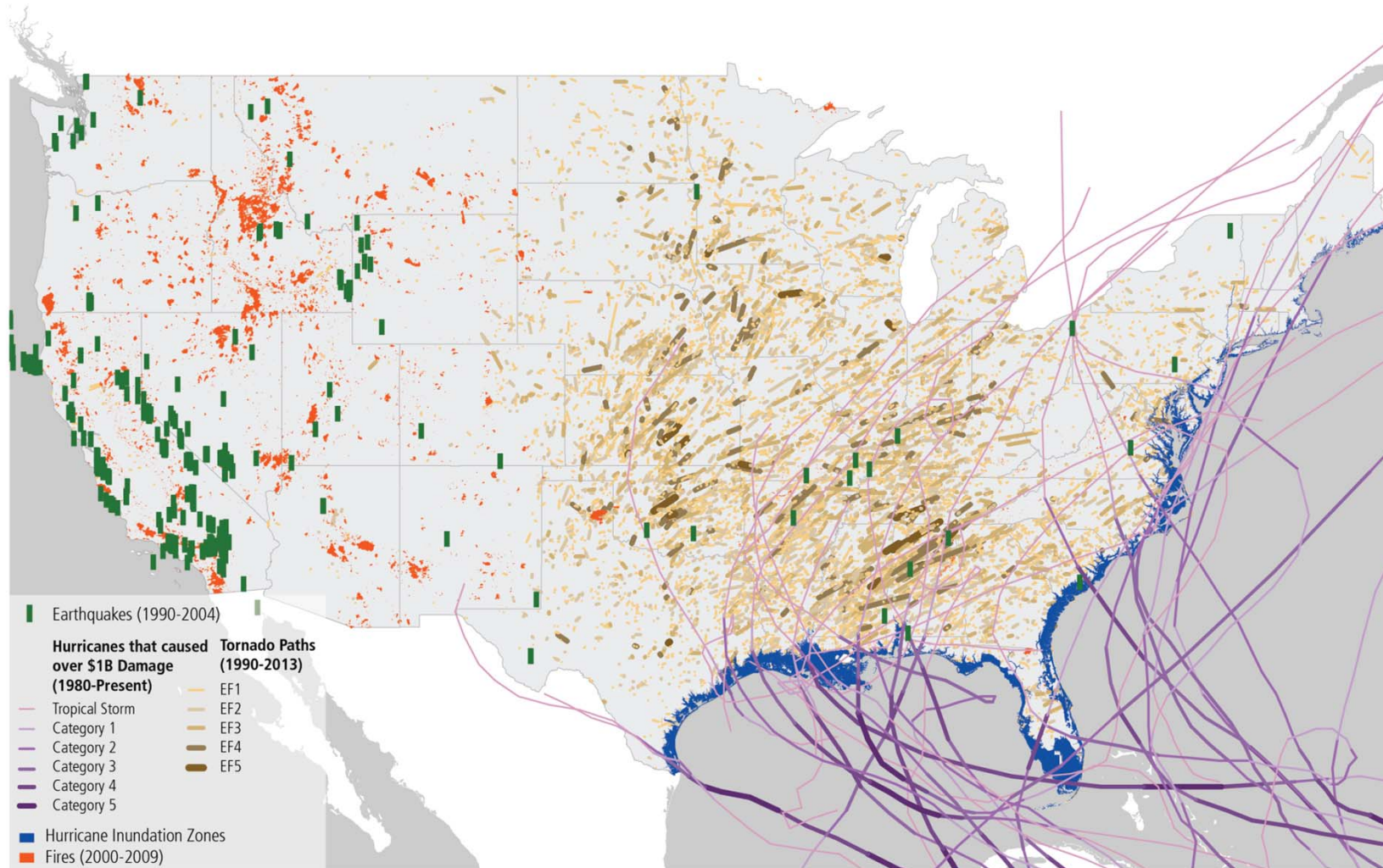
# Framing TS&D Infrastructure

- The United States has one of the most advanced energy systems in the world
- The energy transmission, storage, and distribution (TS&D) infrastructure is increasingly complex and interdependent
- It must handle demanding system requirements (e.g., 24/365, on-demand, highly-reliable energy)
- The longevity and high capital costs mean that TS&D infrastructure decisions today will affect the national energy system for decades to come



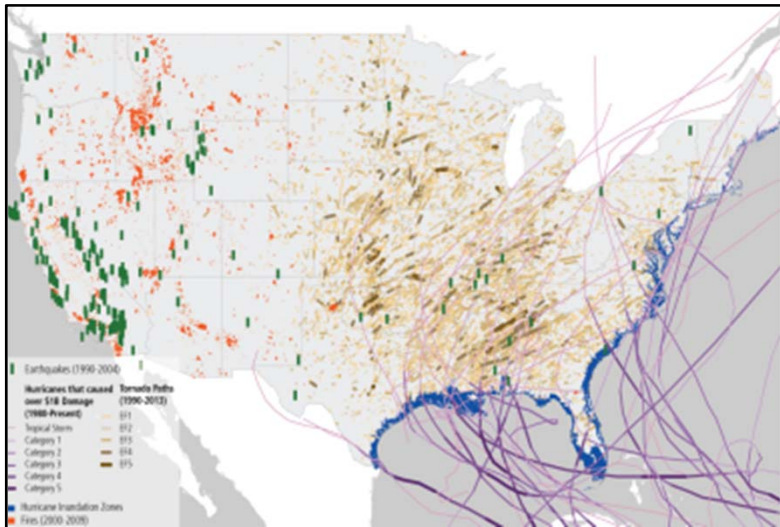
# Vulnerabilities and Disruptions: Natural Disasters

## Tornado and Hurricane Tracks, Wildfires, Earthquakes, and Coastal Inundation

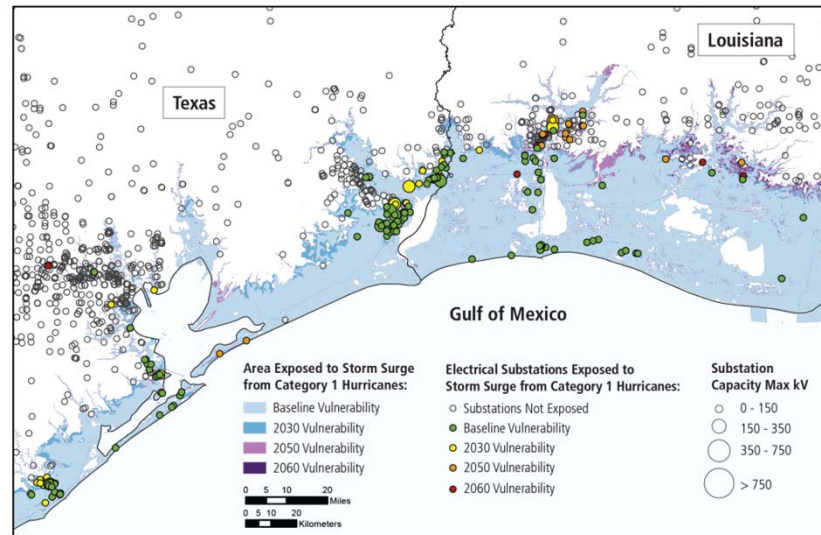


# Vulnerabilities and Disruptions: Natural Disasters

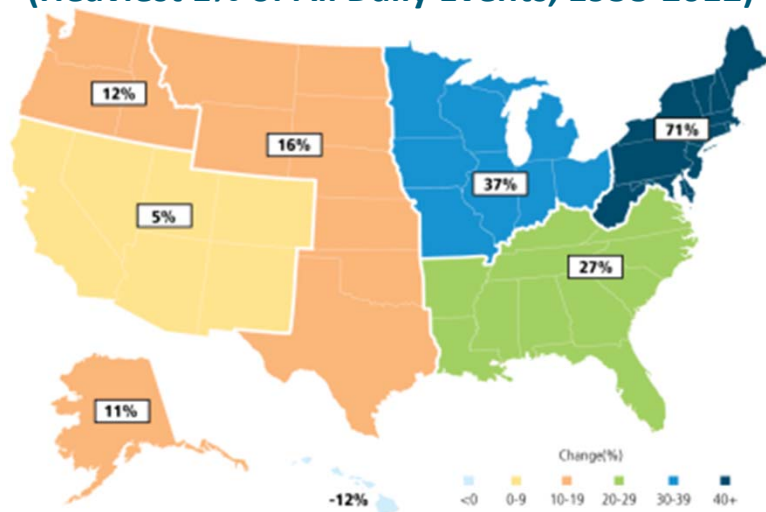
## Tornado and Hurricane Tracks, Wildfires, Earthquakes, and Coastal Inundation



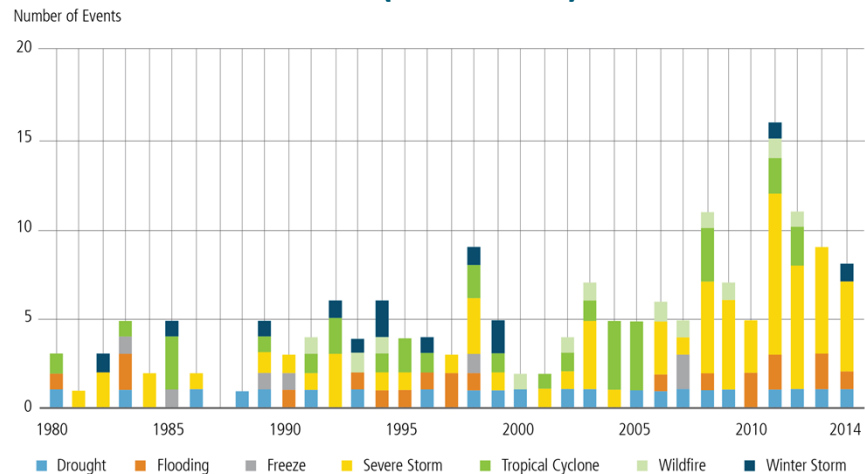
## Gulf Coast Electricity Substation Facilities' Exposure to Storm Surge under Different Sea-Level Rise Scenarios



## Increased Intense Precipitation Events (Heaviest 1% of All Daily Events, 1958-2012)

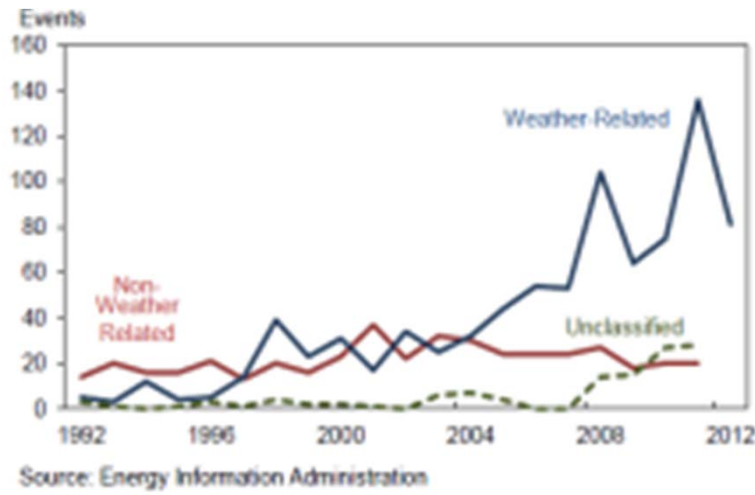


## Billion-Dollar Disaster Event Types by Year (1980-2014)

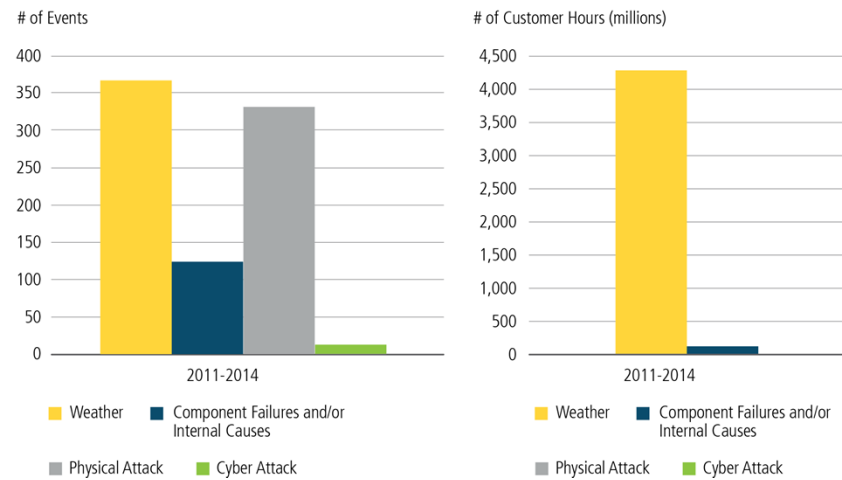


# Vulnerabilities and Disruptions: Electricity Outages

**Observed Outages to the Bulk Electric System (1992-2012)**



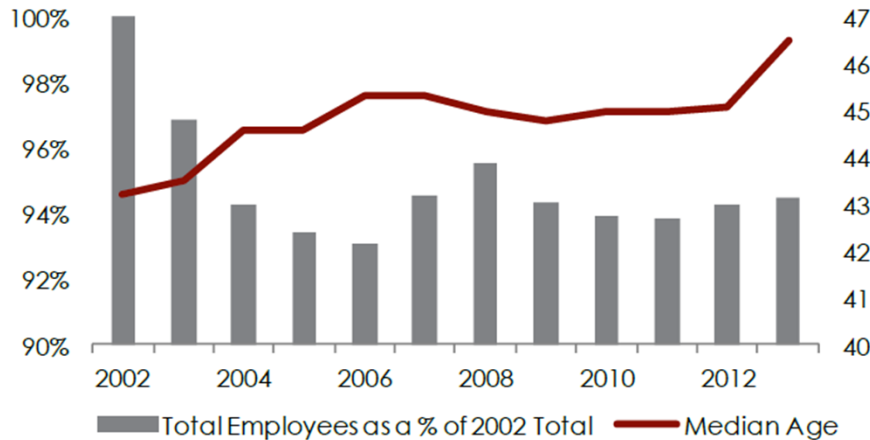
**Electricity Outages by Type of Event and Lost Customer Hours**



# Utility Workforce

## Utility Workforce Trends

### Utility Employment and Median Age Trends (as a % of total)



Over 60% of the workers in electric and gas utilities are eligible to retire or leave the industry within a decade.

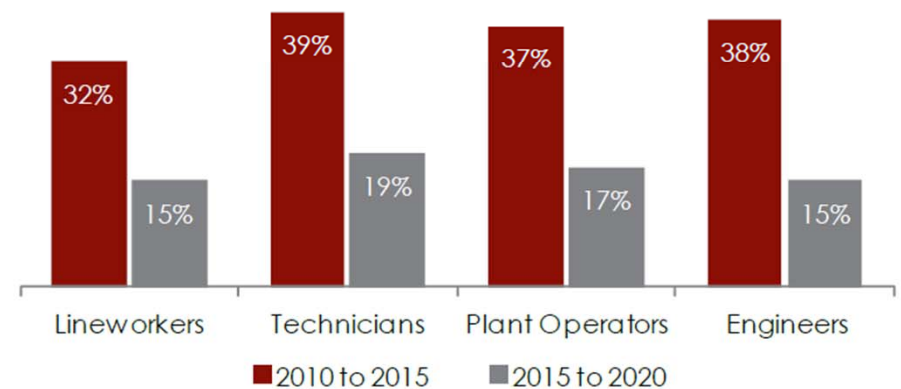
Source: U.S. Bureau of Labor Statistics and CEWD.

Source:

[http://www.harriswilliams.com/sites/default/files/industry\\_reports/ep\\_td\\_white\\_paper\\_06\\_10\\_14\\_final.pdf?cm\\_mid=3575875&cm\\_crmid=e5418e44-29ef-e211-9e7f-00505695730e&cm\\_medium=email](http://www.harriswilliams.com/sites/default/files/industry_reports/ep_td_white_paper_06_10_14_final.pdf?cm_mid=3575875&cm_crmid=e5418e44-29ef-e211-9e7f-00505695730e&cm_medium=email)

## Potential Retirements

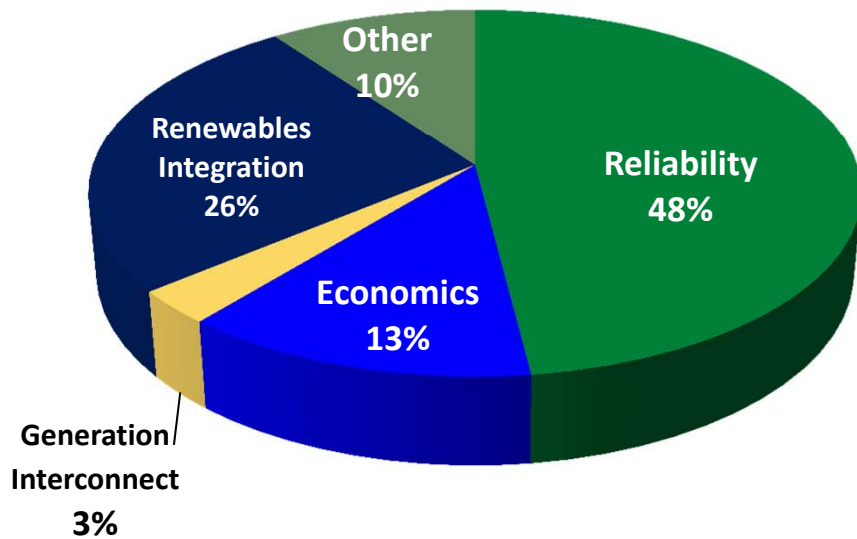
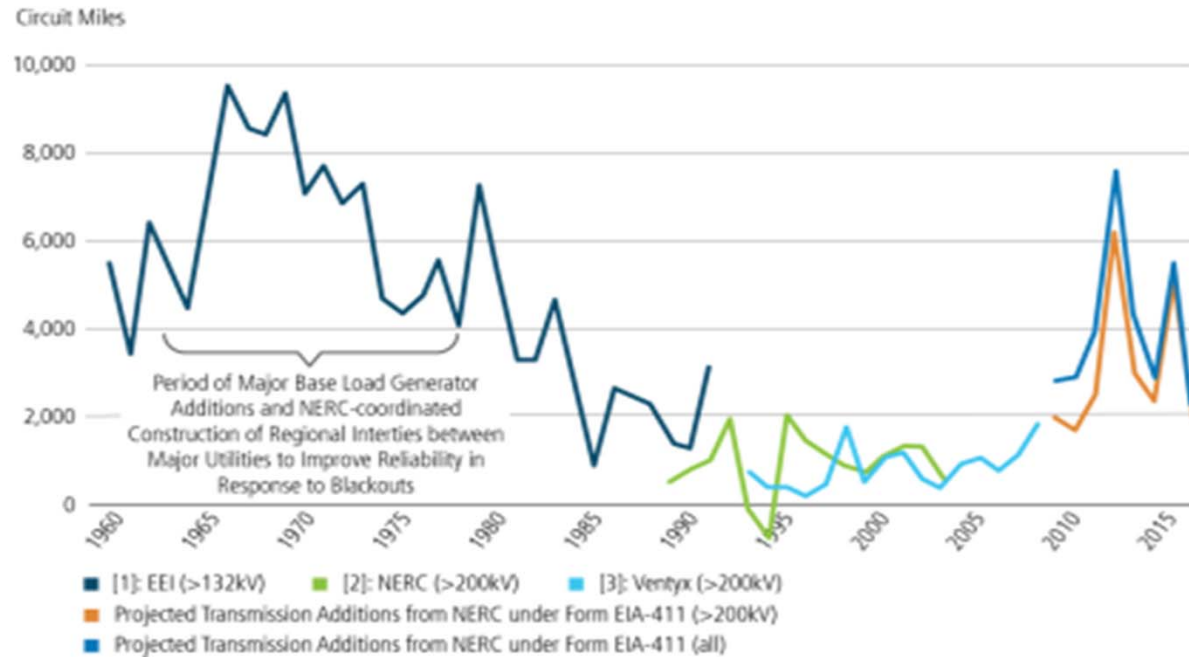
(as a % of total utility workers)





# New Investment: Electricity

## Historic and Projected Expansion of Net Transmission Circuit Miles (1960-2015)

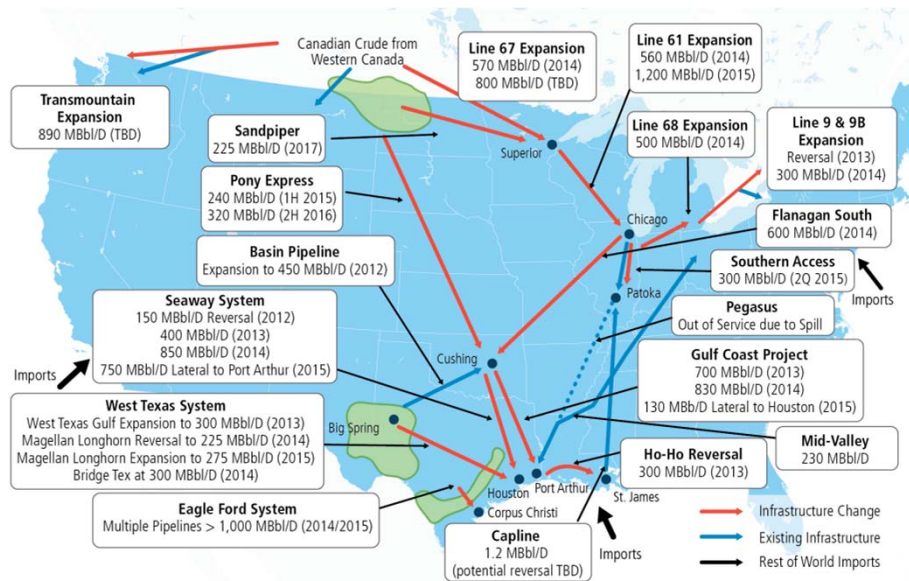


## Reported Drivers of Projected Transmission Addition (2011-2015)

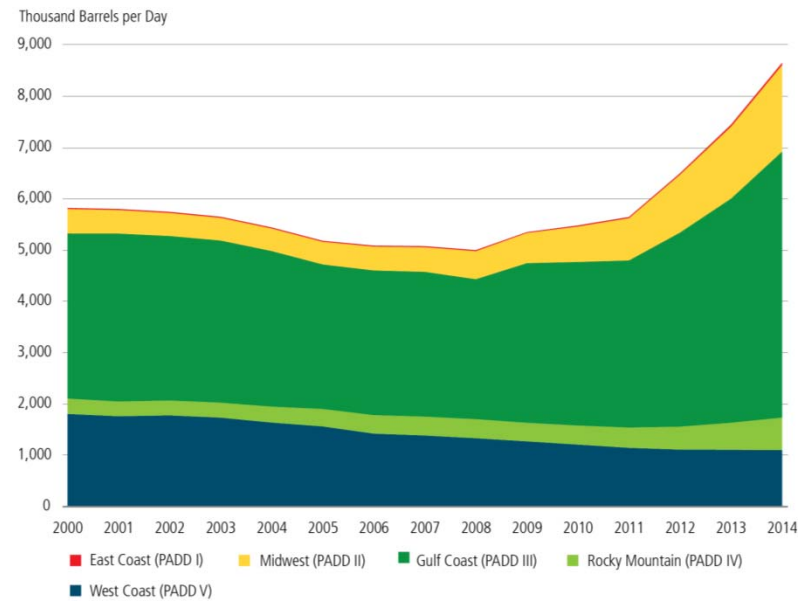


# Supply/Infrastructure: Oil and Gas

## Highlighted Pipeline Reversals and Expansions Accommodating Increased Domestic and Canadian Supply

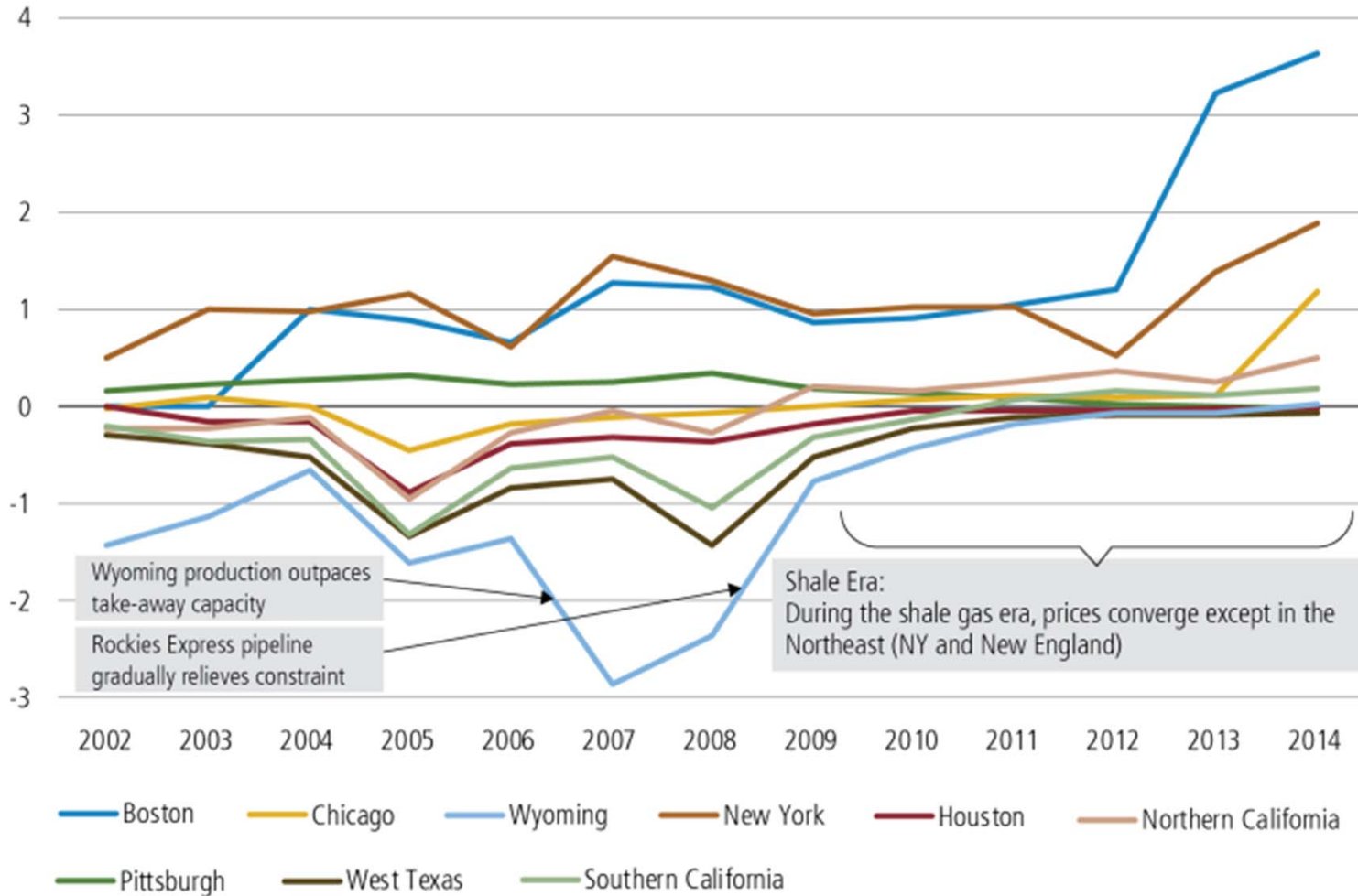


## U.S. Crude Oil Production by PADD



## Importance of Gas Transmission Infrastructure

Henry Hub Price Differential (\$/MMBtu)

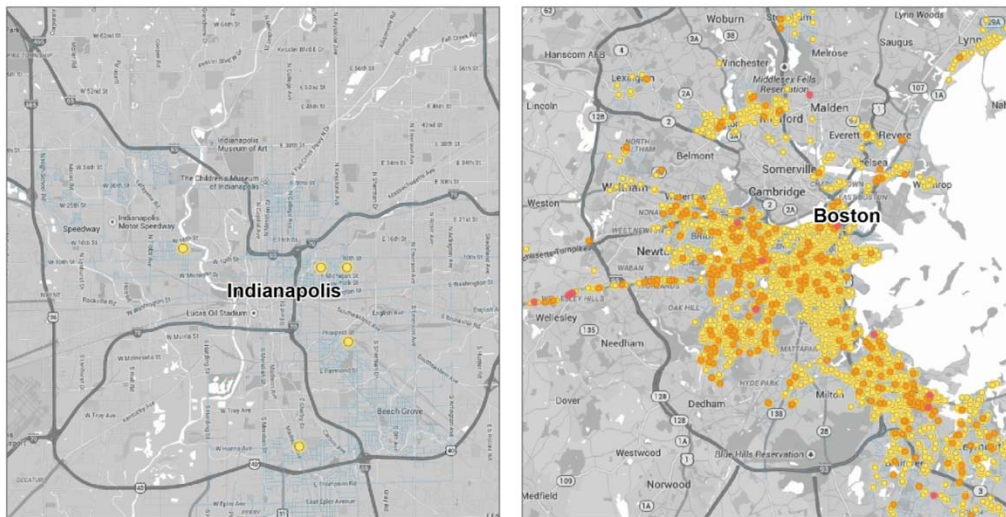


INCREASING RESILIENCE, RELIABILITY, SAFETY, AND ASSET SECURITY



# Vulnerabilities and Disruptions: Pipeline Leaks

## Methane Emissions from Natural Gas Distribution Systems in Indianapolis and Boston (2013)



### Emissions Rate

- **Low** (The same near-term climate impacts as driving a car between 100 and 1,000 miles everyday. Rate: 700 to 9,000 liters/day.)
- **Medium** (The same near-term climate impacts as driving a car between 1,000 and 9,000 miles everyday. Rate: 700 to 9,000 to 60,000 liters/day.)
- **High** (The same near-term climate impacts as driving a car more than 9,000 miles everyday. Rate: More than 60,000 liters/day.)

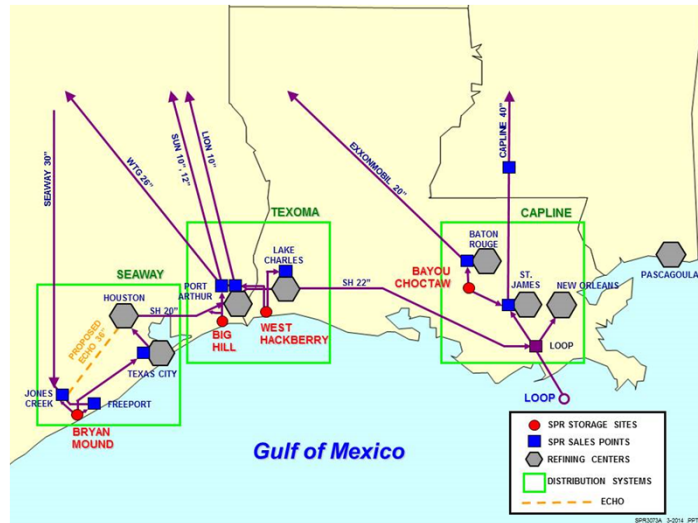
## Expected Replacement Horizons (Forecasted Timeframe in Years)

| Utility Company               | Service Territory         | State | Forecasted Timeframe (years) |
|-------------------------------|---------------------------|-------|------------------------------|
| Philadelphia Gas Works        | Philadelphia, PA          | PA    | 84                           |
| ConEd                         | New York, NY              | NY    | 35                           |
| PECO                          | Greater Philadelphia, PA  | PA    | 33                           |
| PSE&G                         | Newark, NJ                | NJ    | 30                           |
| Pensacola Energy              | Pensacola, FL             | FL    | 30                           |
| Baltimore Gas Company         | Baltimore, MD             | MD    | 30                           |
| UGI                           | Rural Pennsylvania        | PA    | 27                           |
| Consumers Energy              | Detroit, MI               | MI    | 25                           |
| DTE                           | Detroit, MI               | MI    | 25                           |
| National Grid                 | New York, NY              | NY    | 25                           |
| Dominion Hope Gas Co.         | Ohio                      | OH    | 20                           |
| Yankee Gas Services Company   | Rural Connecticut         | CT    | 20                           |
| Peoples Gas                   | Chicago, IL               | IL    | 20                           |
| National Grid - Niagra Mohawk | Rhode Island              | RI    | 19                           |
| Peoples TWP                   | Southwestern Pennsylvania | PA    | 19                           |
| Peoples Natural Gas Co.       | Southwestern Pennsylvania | PA    | 17                           |
| National Grid - Niagra Mohawk | Syracuse, NY              | NY    | 16                           |
| Columbia Gas of Pennsylvania  | Southwestern Pennsylvania | PA    | 15                           |
| Northern Utilities            | Maine                     | ME    | 13                           |
| CenterPoint                   | Arkansas                  | AR    | 12                           |



# Modernizing the Strategic Petroleum Reserve (SPR)

## Selected SPR Findings



SPR Infrastructure in the Gulf of Mexico region

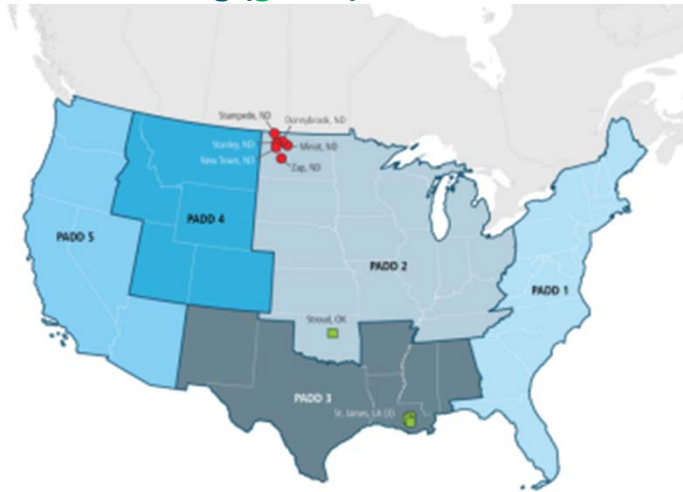


- The SPR was designed to respond to oil embargoes -- to move oil from south to north, and to inland refineries
- Today, the SPR's value is to move oil onto the water and into global oil markets in the event of a disruption, thereby lowering world oil prices and reducing economic harm to the US and its allies
- Congestion in the Gulf of Mexico is significant. Use of the SPR in the Libyan action had limited impact as it displaced some domestic production.
- Design drawdown rate of the SPR: 4.4 million barrels per day
- The SPR is 40 years old

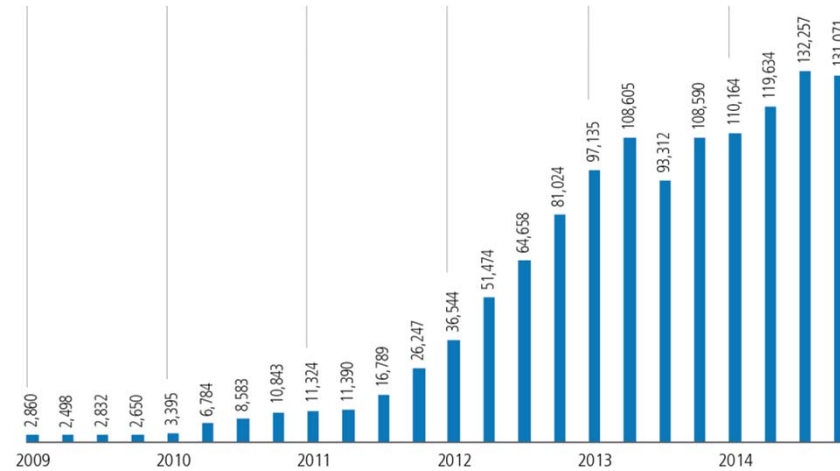


# Supply/Infrastructure: Rail

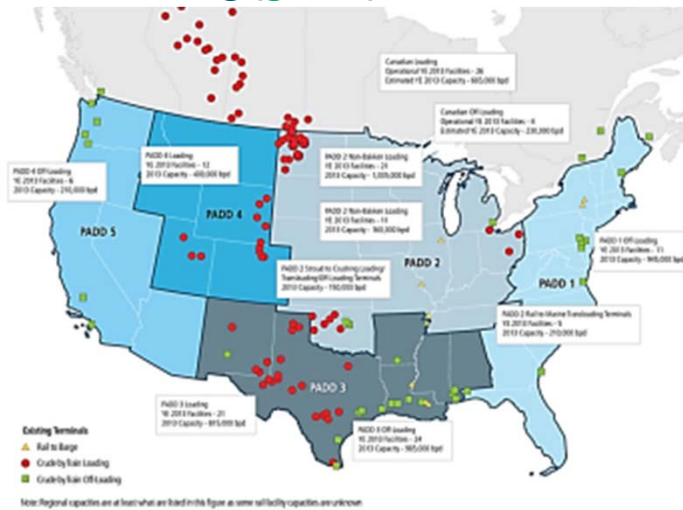
Crude Oil by Train Loading (red) and Offloading (green) Facilities 2010



Class I Railcars of U.S. Crude Oil (Quarterly, 2009–2014)



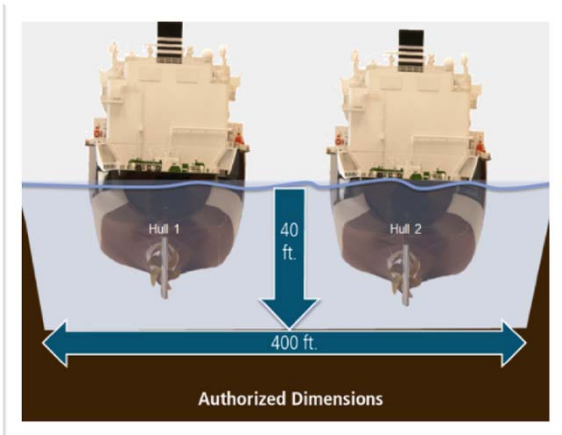
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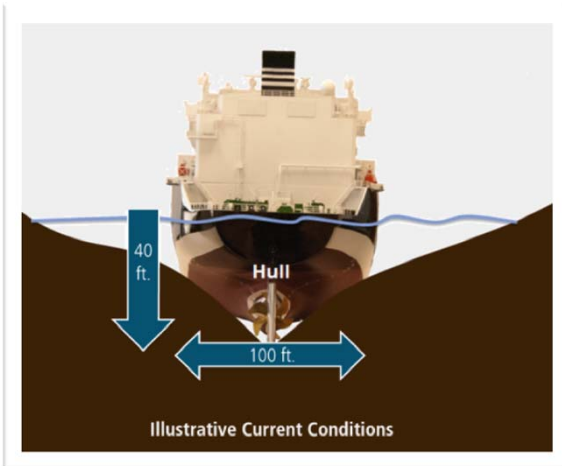
Coal-Fired Power Plants Supplied by the Powder River Basin



# Supply/Infrastructure: Waterways

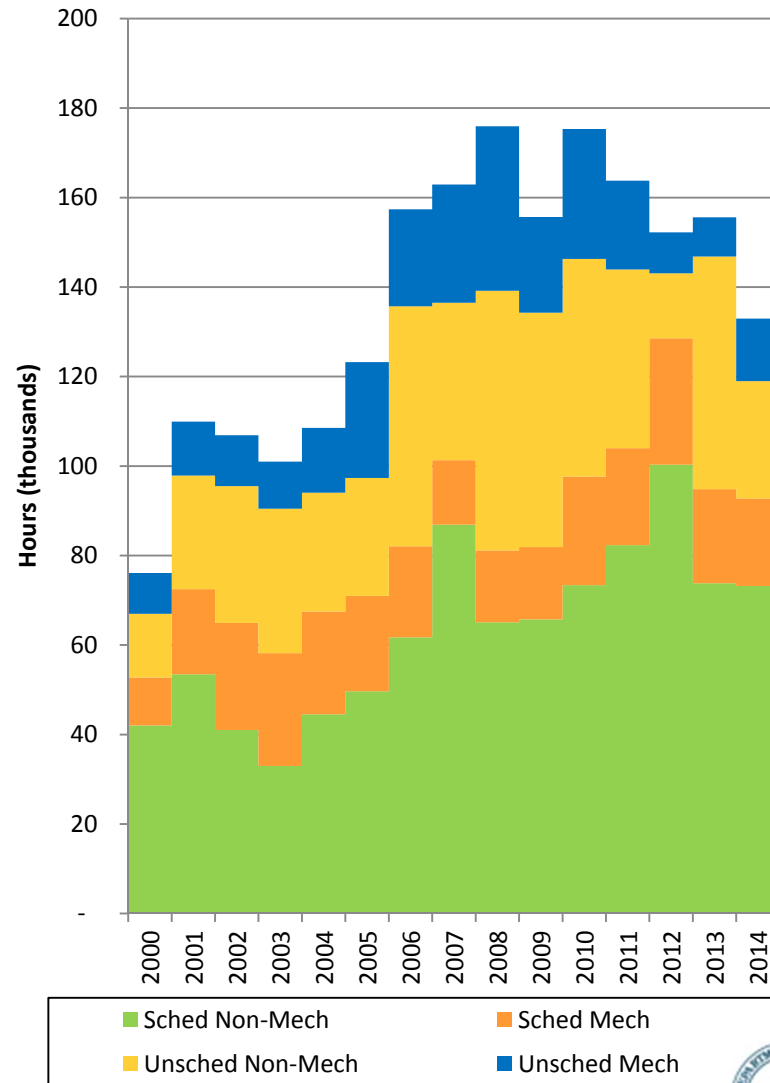


Lake Charles Ship Channel design specs



Current channel conditions

Hours of Lock Unavailability on U.S. Inland Waterways (2000-2014)

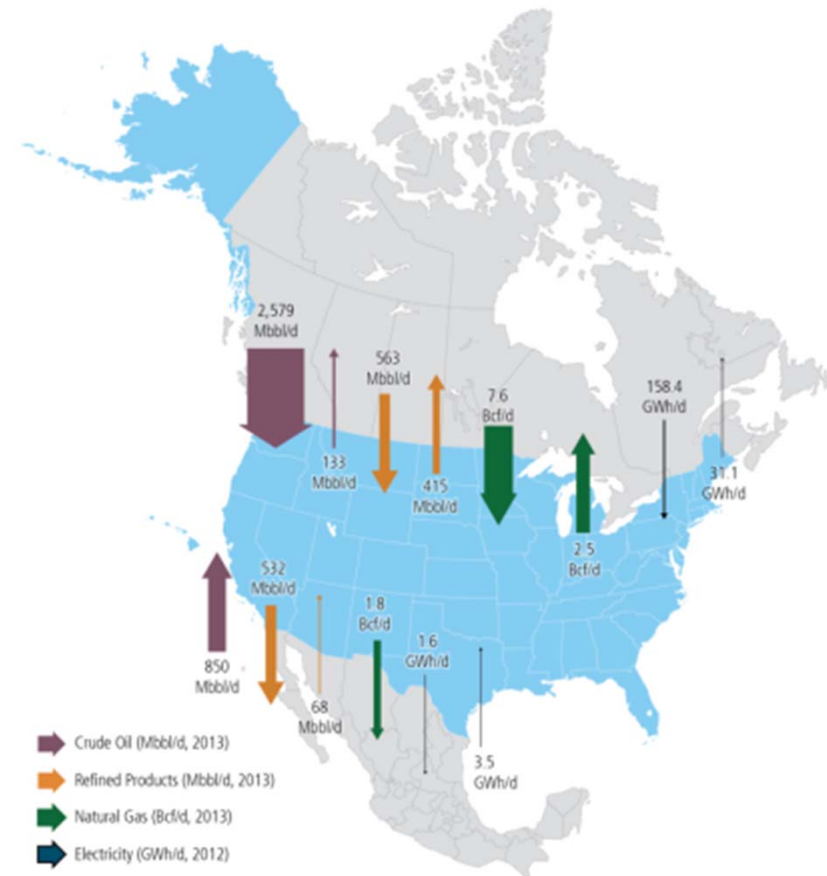


# North America

## Selected Recommendations

- Continue advances that have been made in the North American energy dialogue
- Increase the integration of energy data among the United States, Canada, and Mexico
- Undertake comparative and joint energy system modeling, planning, and forecasting
- Establish programs for academic institutions and not-for-profits to develop legal, regulatory, and policy roadmaps for harmonizing regulations across borders
- Coordinate training and encourage professional interactions
- Partner with Canada and the Arctic Council on Arctic energy safety, reliability, and environmental protection
- Partner with Canada and the Arctic Council on energy delivery to remote areas
- Promote Caribbean energy TS&D infrastructure

## North American Energy Flows



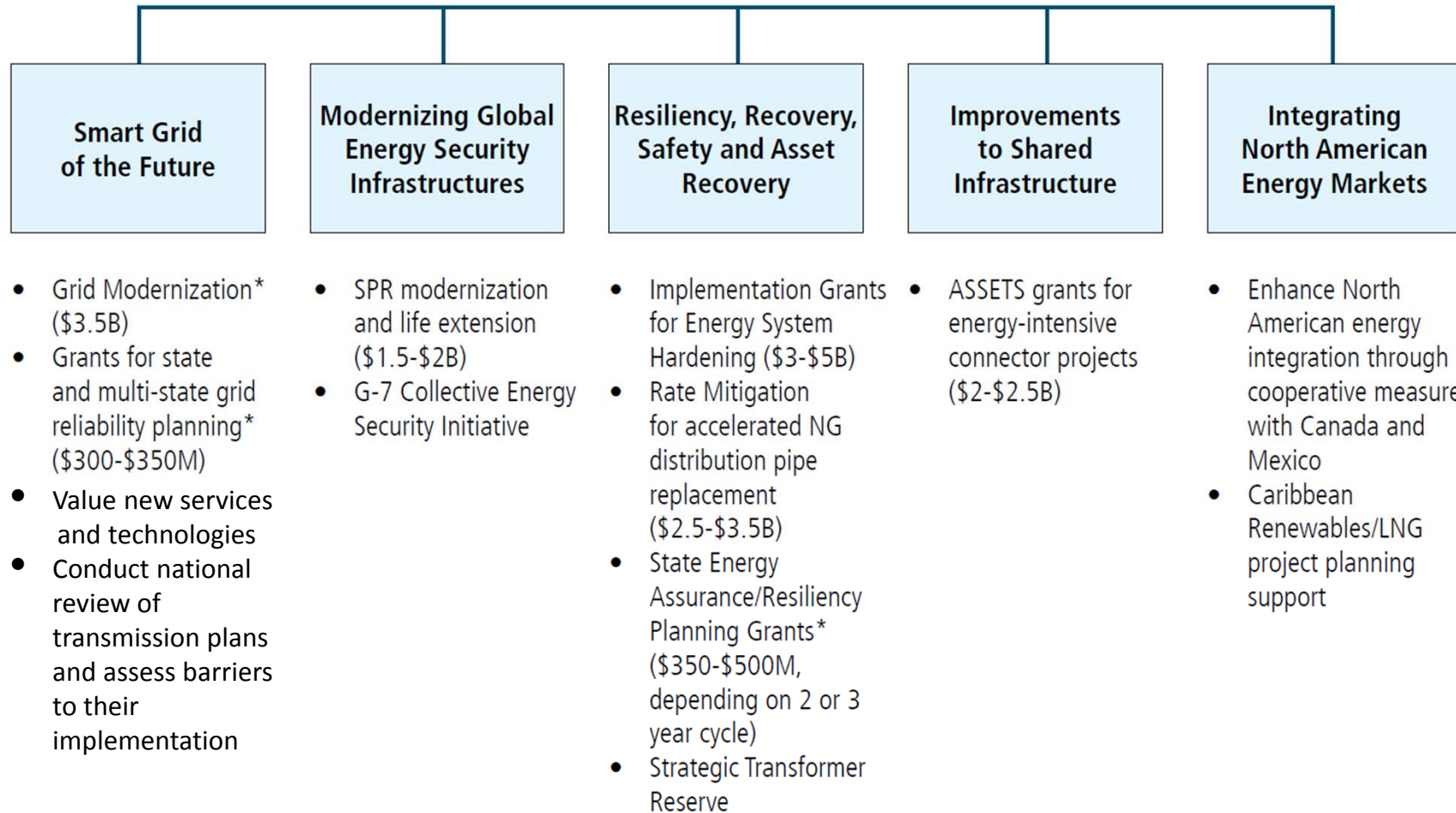


***“Building a resilient, reliable, safe, and secure energy infrastructure is a national priority and vital to American competitiveness, jobs, energy security, and a clean energy future.”***

The Quadrennial Energy Review, April 2015



# SELECT RECOMMENDATIONS





[www.energy.gov/qer](http://www.energy.gov/qer)

