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

**Technology Advances**
- Solar (central and rooftop)
- Wind
- Demand-side
- Hydraulic fracturing

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

**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
“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

Graph 1: Observed outages to the bulk electric system (1992-2012)

Graph 2: Electricity outages by type of event and lost customer hours (2011-2014)
Over 60% of the workers in electric and gas utilities are eligible to retire or leave the industry within a decade.
New Investment: Electricity


- Reliability: 48%
- Economics: 13%
- Generation Interconnect: 3%
- Renewables Integration: 26%
- Other: 10%

Reported Drivers of Projected Transmission Addition (2011-2015)
Highlighted Pipeline Reversals and Expansions Accommodating Increased Domestic and Canadian Supply

U.S. Crude Oil Production by PADD
Importance of Gas Transmission Infrastructure

Increasing Resilience, Reliability, Safety, and Asset Security
Vulnerabilities and Disruptions: Pipeline Leaks

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

Expected Replacement Horizons (Forecasted Timeframe in Years)

<table>
<thead>
<tr>
<th>Utility Company</th>
<th>Service Territory</th>
<th>State</th>
<th>Forecasted Timeline (years)</th>
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<td>Peoples Natural Gas Co.</td>
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<td>Columbia Gas of Pennsylvania</td>
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<td>Conservation</td>
<td>Arkansas</td>
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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.)
Modernizing the Strategic Petroleum Reserve (SPR)

Selected SPR Findings

- 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

Crude Oil by Train Loading (red) and Offloading (green) Facilities 2013

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

Coal-Fired Power Plants Supplied by the Powder River Basin
Supply/Infrastructure: Waterways

Lake Charles Ship Channel design specs

Current channel conditions
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
“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

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<tr>
<td>Grid Modernization* ($3.5B)</td>
<td>SPR modernization and life extension ($1.5-$2B)</td>
<td>Implementation Grants for Energy System Hardening ($3-$5B)</td>
<td>ASSETS grants for energy-intensive connector projects ($2-$2.5B)</td>
<td>Enhance North American energy integration through cooperative measure with Canada and Mexico</td>
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<td>Grants for state and multi-state grid reliability planning* ($300-$350M)</td>
<td>G-7 Collective Energy Security Initiative</td>
<td>Rate Mitigation for accelerated NG distribution pipe replacement ($2.5-$3.5B)</td>
<td>State Energy Assurance/Resiliency Planning Grants* ($350-$500M, depending on 2 or 3 year cycle)</td>
<td>Caribbean Renewables/LNG project planning support</td>
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<td>Value new services and technologies</td>
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<td>Strategic Transformer Reserve</td>
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<td>Conduct national review of transmission plans and assess barriers to their implementation</td>
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*Denotes that the funding levels are estimates and subject to change based on various factors such as market conditions, project costs, and regulatory approval.