QUADRENNIAL ENERGY REVIEW:

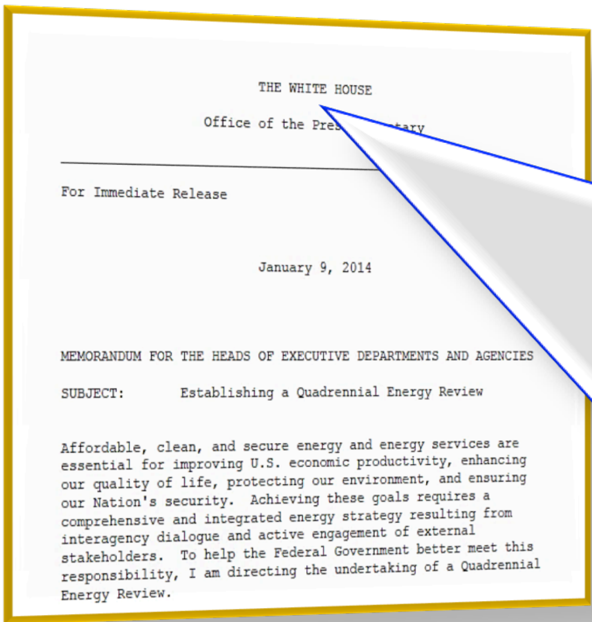
Scope, Goals, Vision, Approach, Outreach

QER Slideshow

May 15, 2014

Energy Policy and Systems Analysis

PM on the Quadrennial Energy Review


THE WHITE HOUSE

Office of the Pres[illegible]tary

For Immediate Release

January 9, 2014

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

SUBJECT: Establishing a 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.

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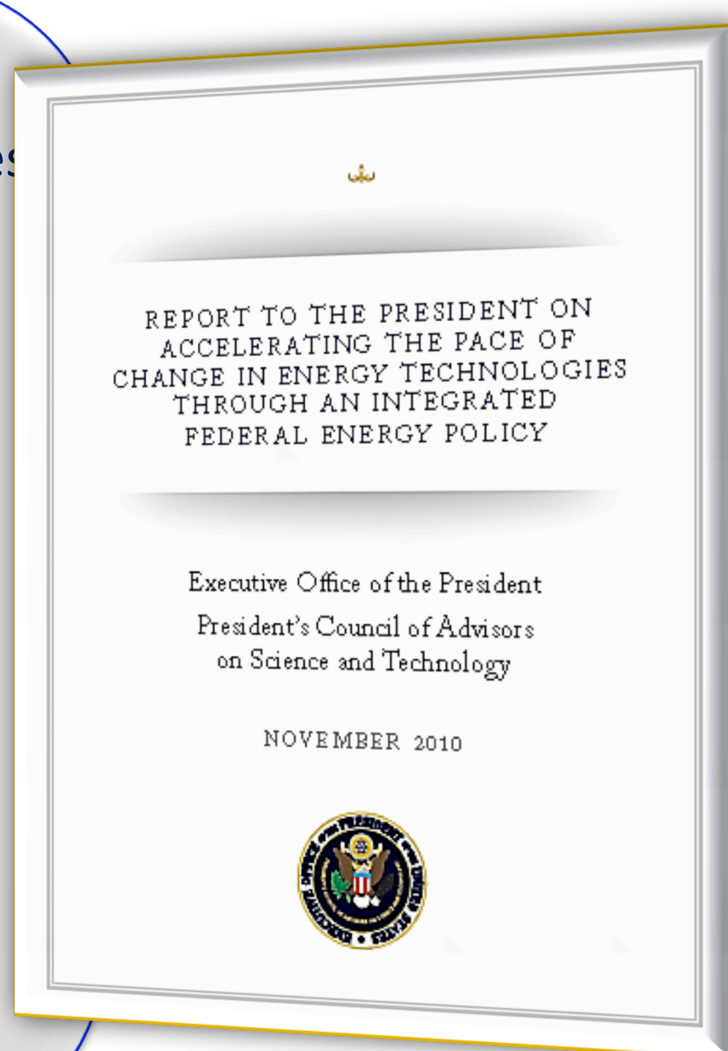
President Barack Obama
January 9, 2014

PCAST Recommendations for QER

- **Integrated view** of the short-, intermediate-, and long-term objectives for Federal energy policy (economic, environmental, and security priorities);
- **Outline of legislative** proposals to Congress;
- **Executive actions** (programmatic, regulatory, fiscal, etc.) coordinated across multiple agencies;
- **Resource requirements** for RD&D and incentive programs; and
- **Strong analytical base** for decision-making.


REPORT TO THE PRESIDENT ON ACCELERATING THE PACE OF CHANGE IN ENERGY TECHNOLOGIES THROUGH AN INTEGRATED FEDERAL ENERGY POLICY

Executive Office of the President
President's Council of Advisors on Science and Technology

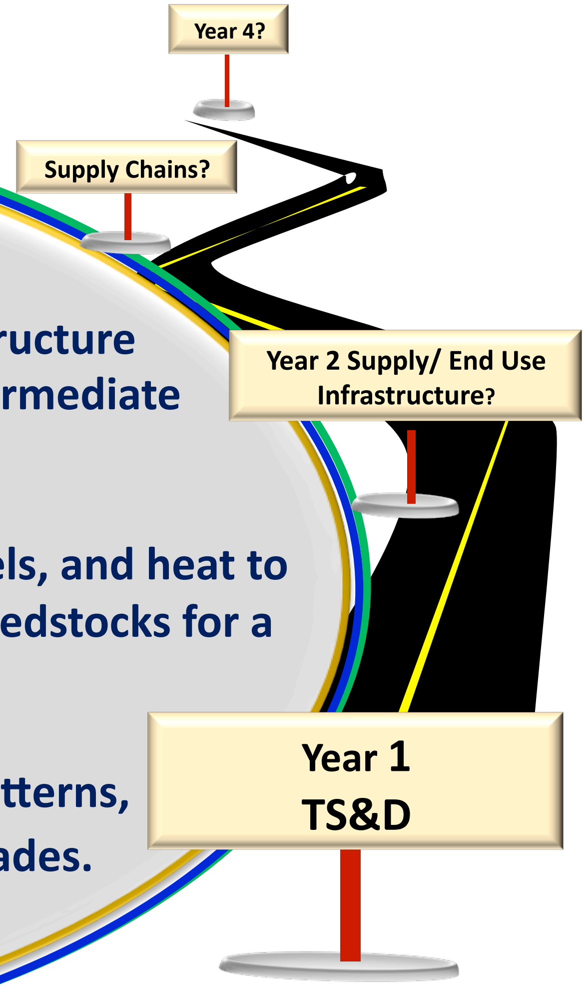
NOVEMBER 2010

Why Focus on Infrastructure?

- Periods of sustained American economic advancement have been supported by enabling infrastructures –canals, railroads, dams/irrigation, highways.
- Energy infrastructures play essential roles in American prosperity, creating competitive advantage via low cost supplies and feedstocks.
- The longevity and high costs of energy infrastructure mean that decisions made today will strongly influence our energy mix for much of the 21st century.

- Vulnerabilities are increasing. A modernized, robust, resilient infrastructure is in the public interest.
- Transforming and modernizing energy infrastructure faces significant challenges, warrants federal policy

QER is a 4 year Roadmap:
Year One Will Focus on TS&D Infrastructure



TRANSMISSION, STORAGE & DISTRIBUTION

- The initial QER exercise will focus on TS&D -- infrastructure that links energy supplies, carriers, or by-products to intermediate and end users, or waste disposal sites.
- TS&D networks help deliver electricity, transportation fuels, and heat to industry and 300 million consumers every day and provide feedstocks for a large range of products.
- These infrastructures tend to set supply and end use patterns, policies, investments and practices in place for decades.

Proposed TS&D Systems to Cover

TRANSMISSION, STORAGE & DISTRIBUTION INFRASTRUCTURE:

Links energy supplies, carriers, or by-products to intermediate and end users, or waste disposal sites

Electricity
- High-voltage transmission lines and substations
- Distribution lines
- All electric grid-related infrastructure, ancillary services, "smart-grid" and metering technologies
- Distributed generation technologies
- Transformer supply chain
- Electricity storage
- Vehicle fueling

Coal transport
- Rail, truck, barge transport
- Export terminals

Biofuel
- Vehicle fueling

Solar
- Grid Interconnection
- Distributed technologies

Wind
- Grid Interconnection

Natural Gas
- Natural gas gathering lines (production-stage or processing-stage)
- Interstate pipelines
- Natural gas storage facilities
- Processing facilities (including processing at production sites)
- Local distribution systems
- LNG production/ storage facilities (including export terminals)
- Vehicle fueling
- LPG distribution

Oil/Petroleum Products
- Crude oil pipelines
- Crude oil and products import and export terminals
- Truck and rail systems that transport crude oil from production sites to ports of refineries
- Oil refineries
- Oil and fuel storage facilities
- Strategic Petroleum Reserve
- Rail, truck ,barge, pipelines systems to transport refined product to consumers
- Fuel terminals and vehicle fueling stations

Nuclear
- Uranium Processing Facilities
- Road/Ship/Rail Transport of Fuel

Carbon dioxide
- Pipelines
- Compressors
- Storage facilities

Biomass
- Transport of Raw Feedstock
- Feedstock Processing
- Derived Product Transport
- Derived Product Distribution

Example systems, many interdependent

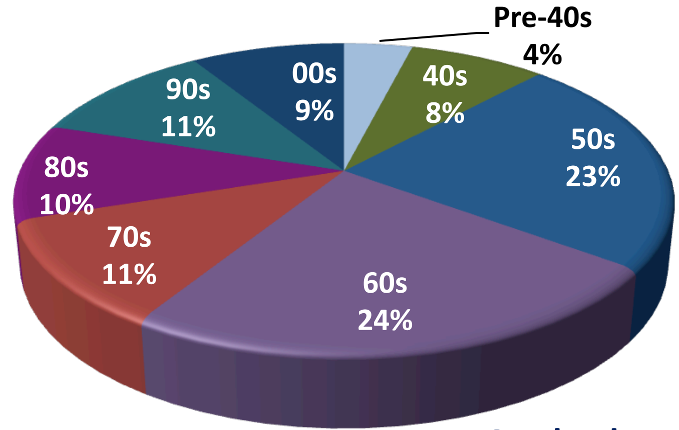
TS&D Systems have Limitations, Face Growing Vulnerabilities

Limitations of Current System

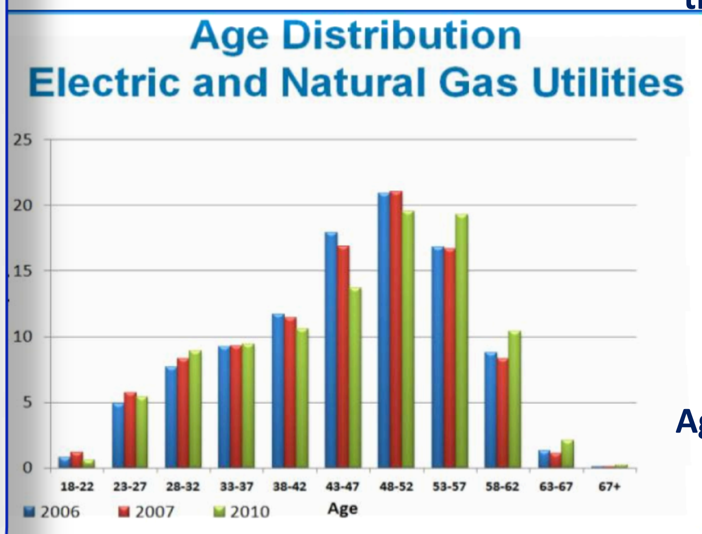
Age: Over 50% of the nation's gas transmission and gathering pipelines were constructed in the 1940s, 1950's and 1960's.

Cost: EEI estimates that by 2030, we will need to at total investment of $1.5 trillion to $2.0 trillion by the electric utility industry. Natural gas infrastructure investment needed: $19.2 billion/ yr. by 2030.

Workforce: Over 60% of the workers in areas like electric and gas utilities are likely to retire or leave the industry within a decade.



Age by decade of gas gathering/ transmission lines



Age Distribution of Gas/ Electric Utility Employees

Near and Long-term Infrastructure Vulnerabilities Are Growing

Climate Change: Weather related power outages have increased from 5-20 each year in the mid-1990s to 50-100 per year in the last five years.

Cyber-security: 53% of all cyber-attacks from October 2012 to May 2013 were on energy installations.

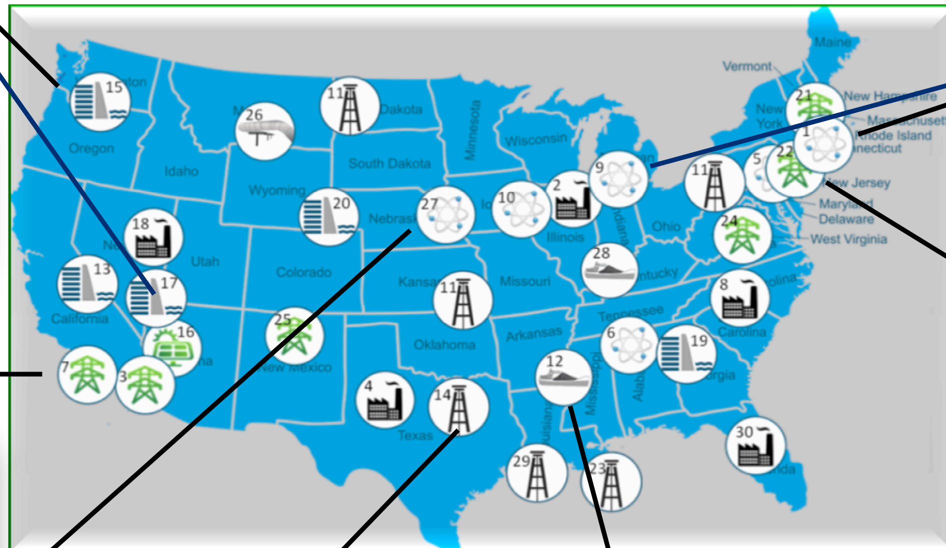
Physical Threats: There were three highly visible attacks on grid infrastructure in 2013. Supply chains for key components of grid infrastructure are not robust.

Interdependencies: The interdependencies of the electric and fuel infrastructures seen in Superstorm Sandy greatly complicated the response and recovery.

Supply/demand Shifts: The lack of pipeline infrastructures for associated gas in the Bakken has resulted in large-scale flaring of this gas, in amount sufficient to be seen from space.

Recent Events Illustrate U.S. Energy Sector Vulnerability to Climatic Conditions

Lower water levels: Reduced hydropower



Wildfires: Damaged transmission lines

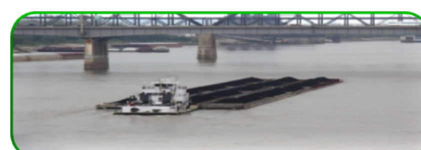
Cooling water intake or discharge too hot: Shutdown and reduced generation from power plants

Intense storms: Disrupted power generation, distribution and oil and gas operations

Flooding: Impacts on inland power plants

Water restrictions due to drought: Limiting shale gas and power production

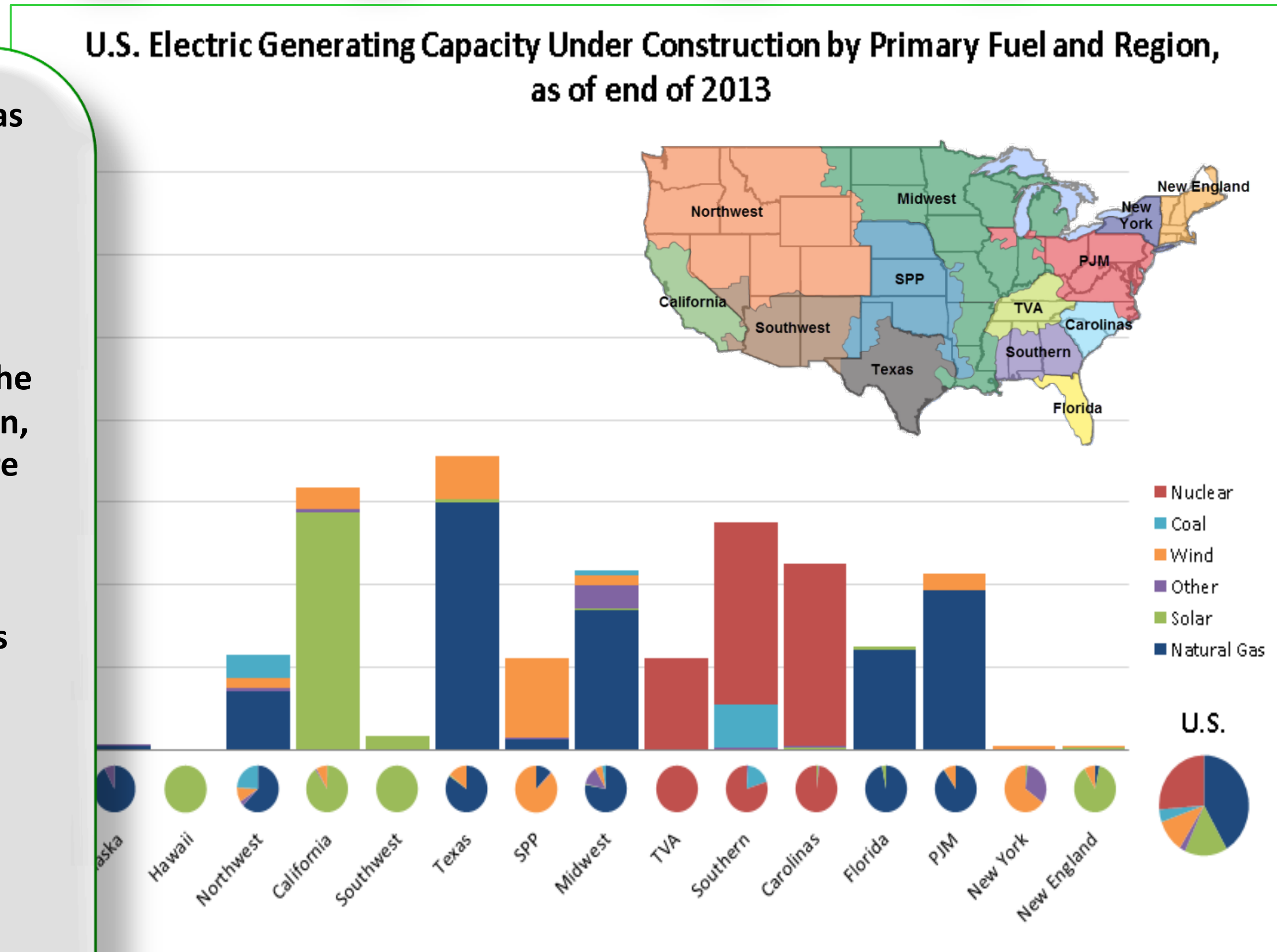
Lower river levels: Restricted barge transportation of coal and petroleum products



Source: U.S. DOE (2013), U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather.

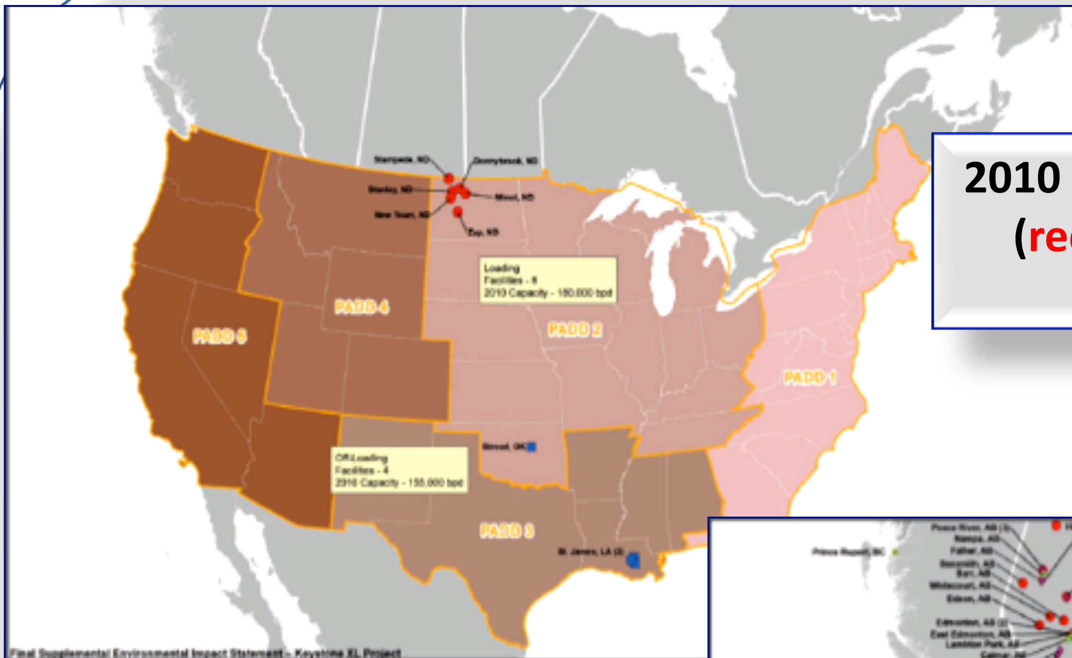
Regional Differences in New Generation Capacity

- At the end of 2013, natural gas was the most common fuel source for expanding generation capacity under construction.
- Southwestern states seeing the majority of solar construction, while wind developments are occurring in Texas/ SPP/ Midwest/NY/Northeast.
- Recent nuclear developments occurring exclusively in the Southeast.
- The average new generation unit is much larger in Southeast than in other regions of the country.



Source: EIA *Electric Power Annual*

Supply/Infrastructure Geography Changing Rapidly

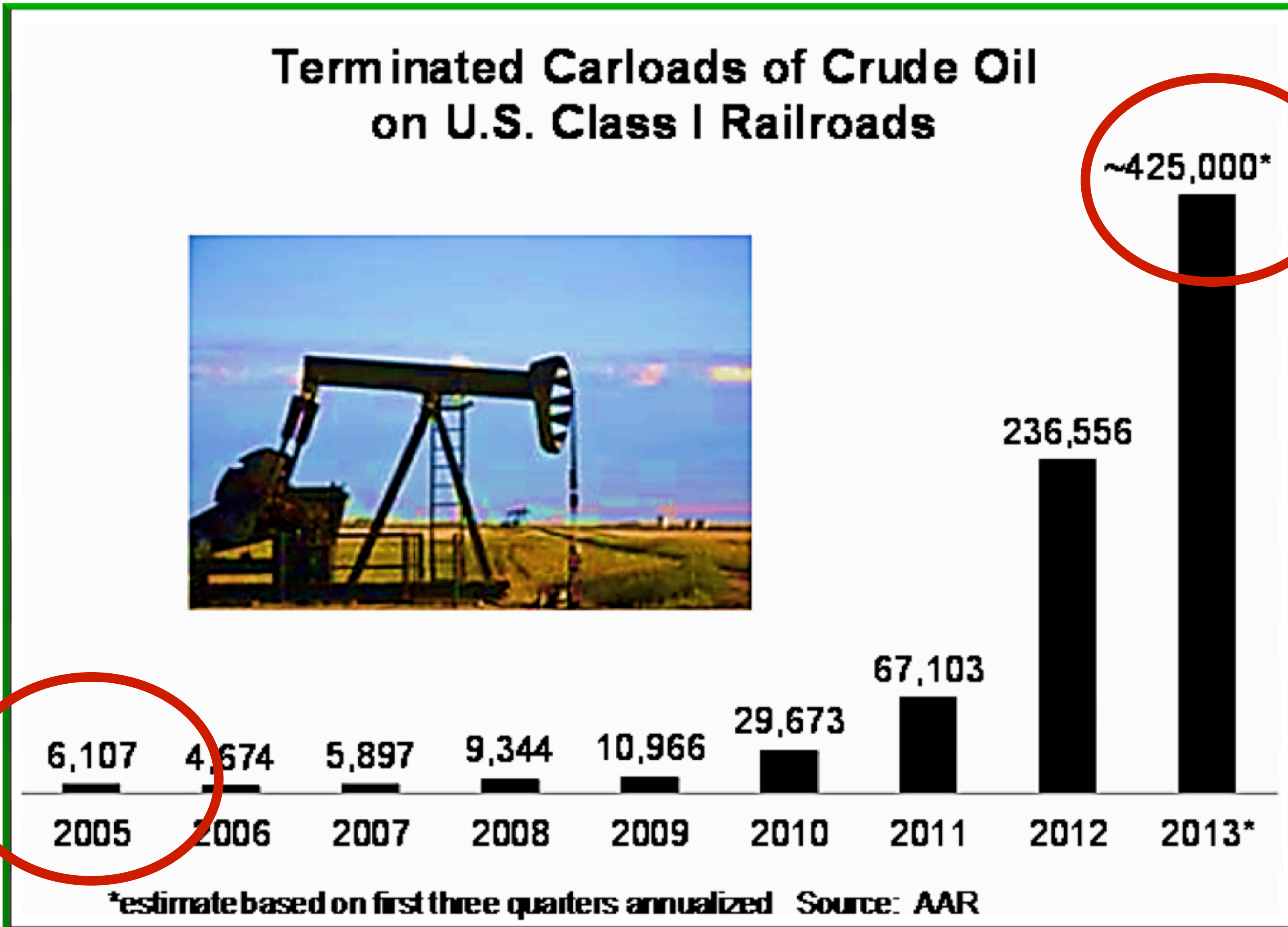


2010 Crude Oil by Train Loading (red) and Offloading (blue) Facilities

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

Source: Final SEIS, Keystone XL Project; Chapter 1.4, Market Analysis.

Growth in Oil Transport by Rail



National Goals, Desirable Characteristics for Infrastructures in 2030

National Energy Goals

Economic Competitiveness: Energy infrastructure should enable the nation to, under a level playing field and fair and transparent market conditions, produce goods and services which meet the test of international markets while simultaneously maintaining and expanding jobs and the real incomes of the American people over the longer term. Energy infrastructures should enable new architectures to stimulate energy efficiency, new economic transaction, and new consumer services.

Environmental Responsibility: Energy infrastructure systems should take into consideration a full accounting (on a life-cycle basis) of environmental costs and benefits in order to minimize their environmental footprint.

Energy Security: Energy Infrastructure should be minimally vulnerable to the majority of disruptions in supply and mitigate impacts, including economic impacts, of disruptions by recovering quickly or with use of reserve stocks. Energy security should support overall national security.

Desirable Characteristics, 2030

Minimal-environmental footprint. Energy systems should be designed, constructed, operated and decommissioned in a manner that is low carbon, and with minimal impact to water quality and quantity; and minimize the land use footprint, impact on biological resources, and toxic emissions.

Affordability. Ensures system costs and needs are balanced with the ability of users to pay. (Note three potential balancing points: overall system costs, system needs/benefits, and system cost allocation). Also, estimating avoided costs can be more complex than for simple levelized costs – calculations require tools to simulate the operation of the power system with and without any project under consideration.

QER: Will provide four year planning horizon to enable these energy infrastructure characteristics in 2030.

Robustness. A robust energy system will continue to perform its functions under diverse policies and market conditions, and has its operations only marginally affected by external or internal events. Sub characteristics of robustness include:

- *Reliability.* Sturdy and dependable, not prone to breakdowns from internal causes (e.g. due to component failures);
- *Resiliency.* The ability to withstand small to moderate disturbances without loss of service, to maintain minimum service during severe disturbances, and to quickly return to normal service after a disturbance.

Flexibility. Energy infrastructure that accommodates change in response to new and/or unexpected internal or external system drivers. Sub-characteristics of flexibility included:

- *Extensibility.* The ability to extend into new capabilities, beyond those required when the system first becomes operational.
- *Interoperability.* The ability to interact and connect with a wide variety of systems and sub-systems both in and outside of the energy sector.
- *Optionality.* Provides infrastructures or features of infrastructures that would allow users to maximize value under future unforeseen circumstances.

Scalability. Energy infrastructure should be able to be sized to meet a range of demand levels. Systems can be scalable by being replicable, modular, and/or enlargeable.

Safety. Energy systems should be designed, constructed, operated and decommissioned in a manner that reduces risks to life or health.

QER Timeline and Framework

QER Process: One-Year Plan

Phase 1: Preliminary Work

2 months

Phase 2: Infrastructure Analysis and Engagement

6 months

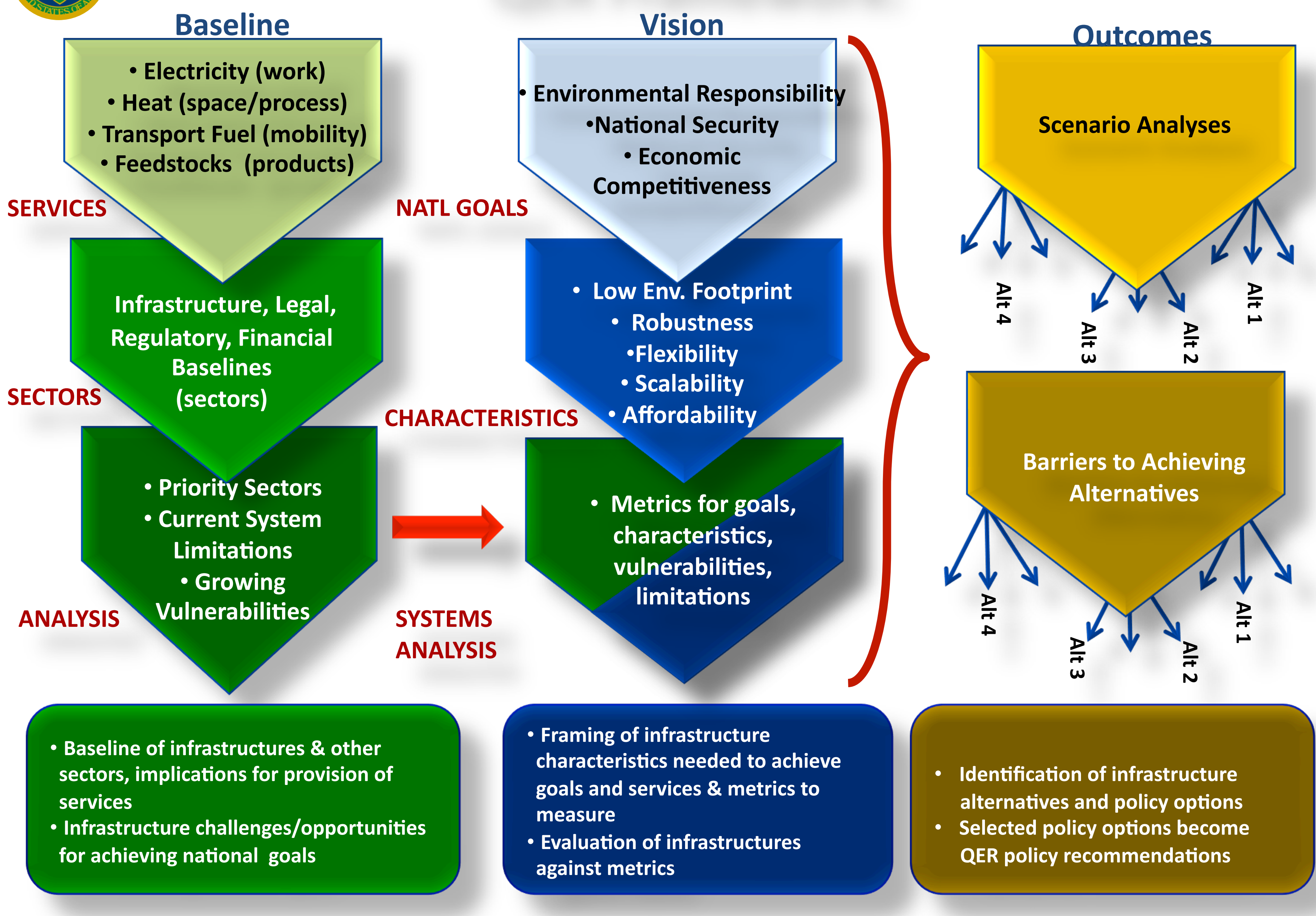
Phase 3: Policy Analysis and Engagement

6 months

Phase 4: Approval Process

2 months

QER Framework:



Interagency, DOE, and External Stakeholder Coordination

Interagency Consultation, Stakeholder Engagement

Agency Stakeholders

- Agriculture
- Defense
- Commerce
- EPA
- HHS
- Homeland Security
- HUD
- Interior
- Labor
- State
- Transportation
- Treasury
- Veterans Affairs
- White House, other

DOE Stakeholders

National Labs
SEAB/PCAST

QER

Co-chaired by DPC, OSTP

Energy/Science Programs

External Stakeholders

- Congress
- Industry
- NGOs
- State, local and tribes
- Financial Community
- Academia
- Public
- Canada, Mexico

DOE Office and Interagency Policy Equities

- Examples of QER-related equities:
  - High-level policy **goals** (e.g., GHG avoidance) or techno-economic **assumptions** (e.g., GW deployed or retired in year 2025)
  - Direct **regulatory, permitting** or **oversight** role
  - Subject matter and technology **expertise**
  - **Modeling and analysis** capability, in-house or Lab
  - Engaged **Stakeholder** base and **Advisory Groups**
- Changes with focus of later QER installments

Planned Public Events

- **Vulnerabilities (Cyber, Physical, Climate, Interdependencies)** *Washington, DC (April 11)*
- **Infrastructure Constraints—New England** *Providence, RI & Hartford, CT (April 21)*
- **Petroleum Product TS&D** *New Orleans, LA (May 27)*
- **Electricity TS&D—West** *Portland, OR (July 11)*
- **Infrastructure Constraints—Bakken** *North Dakota (August 8)*
- **Electricity TS&D—East** *New Jersey*
- **Rail, Barge, Truck Transportation** *Chicago, IL (August 8)*
- **Water-Energy Nexus** *San Francisco, CA (June 19)*
- **Finance and Market Incentives** *New York, NY*
- **Natural Gas TS&D** *Pittsburgh, PA (July 21)*
- **State, Local and Tribal Issues** *Santa Fe, NM (August 11)*
- **Gas-Electricity Interdependence** *Denver, CO (July 28)*
- **Infrastructure Siting** *Cheyenne, WY (August 21)*
- **Rural Electricity, Biomass Processing and Transportation** *Iowa*
- **Business/Economic Development** *Atlanta, GA*
- **Final Meeting** *Washington, DC*

WHY STAKEHOLDER ENGAGEMENT?

Build on Existing Work

Identify Key Issues

Involve Public

GUIDING PRINCIPLES

Transparency: Everyone has access to the process

Accountability: Stakeholders' input will be considered

Analytical Approach

QER Analysis Process

Policy Goals → Baseline and Scenarios → System and Policy Options → Policy Analysis → Recommendations

- **Develop Vision Statement (done)**
- **QER baseline, systems and scenario analyses**
  a. Baseline / Business As Usual (BAU)
     1. Prepare baseline reports on the state of systems (Literature & Analytic Review)
     2. Establish reference case (proposed: EIA- Annual Energy Outlook 2014 (AEO), with EPSA fine tuning)
  b. Assess the Reference Case against the metrics and vision
  c. Perform sensitivity analyses on the reference case: compare infrastructure needs
  d. Perform scenario analysis, including:
     1. Storyline scenarios
     2. Event-driven analyses
- **Craft policy alternatives**
- **Policy analysis**
- **Make policy recommendations, including executive actions, legislative proposals, recommended further research**

Requested Results from BAU process

Age

- Provide age distribution of transmission assets nationally and regionally
- Discuss the importance of age for transmission performance (direct link, some link, no link, uncertain)

Cost

- Estimate capital costs of transmission expansion, new development of assets (dollars, time, other)
- Estimate costs of cybersecurity or other software requirements

Workforce

- Describe patterns regarding technical professionals and skilled craftsmen
- Summarize concerns regarding available workforce

Environment

- Describe how climate extremes might affect/impede/interrupt system performance
- Describe impacts of the system on climate or environment, relevant concerns and regulation

Safety

- Highlight trends in safety and what can affect routine safe operation

Analysis/Candidate Scenarios

- ***Analyses of infrastructure in each sector to achieve the high-level economic, environmental, reliability, and resilience goals***

- **A range of economic scenarios**
  - EIA-AEO 2014 reference case
  - Greater degrees of economic challenge (e.g., low GDP growth and high world energy prices)
  - Higher productivity growth (e.g., high GDP growth coupled with stable or declining energy demand)

- **A range of technology *scenarios***
  - Aggressive carbon reductions by 2030; impacts on energy mix in general and in the electricity sector specifically
  - Greater direct consumer control of energy systems through rooftop PV, smart grid technology, and other consumer-directed demand management
  - Low-cost deployment of renewable energy technologies
  - Low cost of maintaining existing and building new nuclear power plants (e.g., small modular reactors)
  - Low-cost natural gas that allows higher utilization in electricity generation, transport, chemicals, and export, and possibly carbon capture and storage (CCS)
  - Widespread economic deployment of CCS for coal and natural gas .

Needed input on questions for electric, liquid fuels and natural gas TS&D

- What are important supply/demand shifts?
- What are key interdependencies?
- What are key physical/cyber threats?
- What are key climate-related effects?
- What are safety trends?
- What are important regional differences?
- What are important connections & relationships with TS&D infrastructure in Canada and Mexico?

Select Questions on Natural Gas

- What new natural gas processing, transmission, storage, distribution, and LNG-related infrastructure is necessary before 2030?
- What are the key safety, security and environmental issues for these systems, current and future?
- What are key electric coordination issues that should be resolved to support the potential for increased gas use for power generation while maintaining adequate reliability?
- What is the range of estimated GHG emissions from gas systems? Provide a reconciliation crosswalk. What are the costs of reducing methane emissions from processing, transmission, storage, distribution and LNG-related systems?
- What are the key potential cyber and/or physical threats to the natural gas system? Are they significant?
- What are workforce effects of building new and refurbishing existing infrastructure?
- What are the notable regional issues for natural gas?
- How safe and reliable is natural gas infrastructure? How reliable? Is this improving, getting worse or staying about the same? Please provide relevant statistics.
- What new information on natural gas systems should be collected, assessed, and potentially distributed to facilitate an energy system that makes America economically competitive, secure and improves environmental conditions?
- Are there significant bottlenecks in building new infrastructure to meet changing needs?

Select Questions on Electric Power

- What are the systems' vulnerabilities (e.g., cyber and physical attacks, extreme weather events)? What methods/metrics can be used for planning and paying for resilience?
- How well can the current TS&D system support Greenhouse Gas reductions?
- What are the limiting factors in integrating and maintaining zero and low carbon generation in the operation of the power grid? How can new transmission, storage and demand response facilitate the incorporation of zero and low carbon generation? What steps can be taken to facilitate the introduction of advanced technologies to the TS&D grid?
- What improvements can be made in the use of real-time data, analysis and communication of transmission system conditions? How can improved smart grid interoperability standards better integrate customer response into the operation of the transmission system? What is the potential capacity and operating characteristics of direct-control appliances?
- What are the business challenges and opportunities facing the electric industry? How does the current market structure affect the ability to finance infrastructure? Are resource and ancillary services attributes appropriately priced in organized markets? What economic challenges face development of micro-grids? What challenges face development of customer-based options (distributed energy resources and demand response)?
- What policies can facilitate beneficial investments in storage? Can storage be a cost-effective substitute for transmission & distribution investments? What are the physical and economic implications of different types of storage (e.g., distributed batteries v. pumped storage)?
- What steps can be taken to improve the siting and maintenance of transmission facilities under federal discretion?

Select Questions on Liquid Fuels

- Are Strategic Petroleum Reserve (SPR) offloading infrastructure and policies appropriate in light of increased domestic production and pipeline reversals?
- What infrastructure modifications are needed to accommodate rapid shifts in development of North American oil supply and increasing domestic light crude production? Have options such as pipeline direction reversals and throughput improvements been maximized to alleviate congestion and satisfy demand? What is the appropriate role of government in facilitating such adjustments to the liquids fuel system?
- What are the projections for end-of-life retirements across infrastructure and how much of that infrastructure is operating beyond its intended lifespan? Are private infrastructure owners incentivized to make tradeoffs associated with equipment, maintenance, repairs and replacements to address reliability and resiliency? Is government funding appropriate to maintain important government-owned infrastructure (locks, dredging)?
- There are large variations in how alternative fuels infrastructure has developed to date. Is there a government role to help shape this going forward?
- There has been a substantial increase in oil transport by rail. There has also been an increase in number of accidents associated with this transport - how sustainable is increased liquid fuels by rail? What effect will increasing use of rail for transport of oil have on other energy rail uses (coal, ethanol, propane) and non-energy cargos and passenger travel?
- How will crude oil and natural gas price spreads influence the need for expanding NGL infrastructure?

Select Questions on Climate

- What is the potential for T&D infrastructure changes to enable alternative, lower-carbon, more energy efficient energy production and use?
- What are the most appropriate and broadly applicable performance metrics and goals for energy system resilience to climate-related threats?
- What is the capacity of our energy systems to absorb, adapt or recover from climate change (e.g., drought, sea level rise) and extreme weather events; today and in 2030?
- Which alternative policies, technologies and investment solutions would most effectively achieve our emissions and resilience goals?
- What T&D infrastructure changes are needed to reduce direct energy losses and emissions?

Select Questions on Energy Finance

- What are the most important current energy and financial policies and regulations that determine the level of investment in energy infrastructure, particularly for TS&D?
- For identified energy infrastructure needs and upgrades, what are major regulatory, market, and institutional barriers to the flow of private capital? What are effective federal incentives and actions to reduce these barriers and increase private sector investment to enable national economic, environmental, and security goals?
- What emerging or proposed innovations in energy finance and market design can help accelerate the flow of private sector investment to energy infrastructure modernization?
- What are the broader economic and workforce implications of energy infrastructure modernization?
- What key perspectives from the energy and financial sectors are most important when considering energy infrastructure upgrades and investment?

Select Questions on Innovation, Customer Interaction

- What are options or best practices for configuring TS&D systems to allow new technologies (generation, end use, etc.) to compete with one another?
- What are tradeoffs between building in flexibility and fostering competition vs. planning/building for a single system?
- How does penetration of various new alternative fuels and technologies impact oil, gas, electricity, and fueling TS&D infrastructure?
- How can and should TS&D systems be configured to enable more consumer choice?
- To what extent can demand response programs reduce the need for new electricity generation and transmission capacity?

Illustrative Systems Integration Analysis Questions

- What are key system metrics? (e.g., GHG emissions, system costs, others?)
- What are key interdependencies (e.g., gas/electricity, gasoline/electricity, energy/IT systems, etc.)?
- What are important cross-cutting resilience/security/climate issues, and what should be done to mitigate vulnerabilities?
- What is the role of TS&D systems in enabling innovation?
- How are interactions between customers and TS&D infrastructure evolving?
- How do TS&D systems compare and contrast, and where can lessons from one system apply to others?
- What are key regulations that may affect TS&D needs?
- What are competing demands for future capital?

Illustrative Interdependencies

- **Natural Gas – Electricity** (e.g., gas as generation fuel, electricity powering natural gas compressors; do pipelines serve as alternatives to power lines? How does gas price affect renewable and nuclear retirements?)
- **Electricity – Gasoline** (e.g., system resilience and the need for electricity to pump gas)
- **Oil – Natural Gas** (e.g., no. 2 fuel oil in New England capped regional gas prices last winter; patterns of coproduction have implications for oil & gas T&D infrastructure)
- **Water – Thermal Generation** (dependence of generation on water temperature & availability, both for existing and new generation)
- **Water – Energy Transportation** (e.g., barges for coal, other commodities)
- **Energy – Communications Systems** (e.g., dependence of electricity on IT infrastructure & IT infrastructure on electricity; opportunities and cybersecurity challenge of new diagnostics and controls; data center use for demand response)
- **Rail Transport – Oil/coal/ag products/fertilizer** (possible competition on congested lines)

Select Questions for Strategic Comparisons

- What are differences in cost and performance between natural gas pipelines relative to oil pipelines?
- What are the relative risks of pipeline, rail, and barge liquid fuels transport?
- What are key tradeoffs among different modes of transmission and distribution for gas and liquid fuels (pipelines, rail, truck, barge)?
- How has investment varied between organized markets and traditional vertically-integrated electric utilities?
- What are differences in business models and rate structures between gas and electric distribution?
- What are differences in timing for siting electricity vs. natural gas transmission infrastructure?
- Are there fundamental differences in cyber and physical security risks among energy infrastructure systems?

THANK YOU