Making Our Energy Infrastructure Disaster Resilient: Where We Are Today/Where We Need to Go

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National Conference of State Legislatures Task Force on Energy Supply
Hotel Coronado, San Diego, Dec. 10, 2017
Re-enforced and New Lessons Learned from Recent Extreme Weather Disasters

- **2017: Year of Wind, Flood, and Fire**
  - Harvey (Aug. 25) shut down 22 percent of the nation’s refining capacity, disrupted oil and gas transportation networks; caused damage to facilities that leaked more than a million pounds of dangerous air pollutants and caused temporary reductions to Texas Gulf Coast onshore and offshore production.
  - Irma (Sept. 10) caused power outages that affected more than 90 percent of Florida residents with power restored in a relatively short amount of time.
  - Industry officials note overall energy market impacts from both hurricanes have been limited.
  - Maria (Sept. 25) was another story, with Puerto Rico’s electric power grid largely destroyed, leaving more than 90 percent of its population without power and restoration expected to take months.
Re-enforced and New Lessons Learned, California Wildfires of October and November

- Wine country fires during the week of October 8 destroyed at least 8,400 homes and buildings, burned more than 210,000 acres and killed at least 44 people

- PG&E reported at least 17 “electric safety incidents” across eight counties the night of the fires due to downed trees and heavy winds damaging power lines and other equipment
  - Asking state Public Utilities Commission to pass along costs and penalties to the rate payers
  - Costs may be in billions of dollars if PG&E is found responsible for not maintaining power lines and surrounding vegetation to prevent wildfires

- Too early to gauge impacts of ongoing wildfires in LA and San Diego Counties, but high winds a major factor
  - SCE and SDG&E, like PG&E are resorting to intentional blackouts during intense windstorms and wildfires – is an extreme and controversial prevention measure, because sparks from restarts can cause fires if the lines are down

Wine country fire destruction (Photo by Marcus Yam / Los Angeles Times)

Downed power poles burn along Soda Canyon Road in Napa, Calif., on Tuesday, Oct. 10, 2017. Power was out around a large portion of the area. (Jane Tyska/Bay Area News Group)
Looking beyond 2017 to Potential Major Hazards Affecting Energy Infrastructure Resilience

- More severe storms expected more often, compounded by sea-level rise; more intense wildfires, heatwaves, droughts, wind storms, and ice storms

- For much of the nation, not a matter of if, but when for a major earthquake
  - Multiple hazards will include aftershocks, liquefaction, slippage, and widespread numerous spreading wildfires
  - Interdependencies and co-located infrastructure at fault crossings are particular concerns
  - Need for sharing GIS and other data to better understand and mitigate associated impacts
Examples of Infrastructure damage in Hypothetical M7.0 Earthquake Affecting San Francisco Bay Area

- Per information from recent interdependencies exercise:

  - Anticipated serious damage to 13 electric power substations with 35 having damaged equipment needing repair and approximately 1.5 million customers out of power with extended outages
  - Gas pipelines expected to be resilient to shaking but vulnerable to displacement from landslides and subsidence
  - Estimated 200,000 people would require relights after the main shock, not including people who proactively shut gas off and surveys to determine pipeline leaks could take months
  - There are many uncertainties in restoration times—“It depends”
  - Estimated 8,000 water pipeline breaks are expected to affect two major water systems in the East and South Bay, impacting co-located energy and other infrastructures
Energy Infrastructure Dependencies and Interdependencies—Key Factors in Risk and Resilience

- Much research and analysis has been done looking at all-hazards impacts to energy and other lifelines and critical infrastructure interdependencies at the federal level.
- Utilities are looking at risk to their internal assets, but commonly do not factor in externalities associated with interdependencies in response, initial recovery, and mitigation decision-making.
Reasons Why We are Behind the Power Curve on Energy and Broader Infrastructure Interdependencies

- Traditional risk assessment approaches do not take into account extensive and increasing concentrations of highly interconnected and often co-located infrastructure assets—physical and cyber in our major metropolitan areas
- Organizational, jurisdiction, and discipline “silos” and ingrained industry and government agency cultures focused internally
- No single authority responsible for addressing interdependency-related risk and resilience decision-making—rests with a broad array of “players” focused on their own missions
- Staff turnovers in utilities are a big problem—needing to relearn what we already know
- Development of interdependencies assessment capabilities remains at the federal level
- “It’s too hard!” Highly complex nature of interdependencies requires examining them at deeper levels in different scenarios and sharing proprietary and sensitive data
Oil Supply Chain Interdependencies and Ramifications for Resilience

- The oil supply chain is a highly interconnected, complex set of thousands of systems, facilities, assets, and components run by small to global entities, and includes supporting essential services and suppliers.
- Covers from extraction to customer distribution.
- Includes end-to-end assets to extract, produce, store, transport, refine, and distribute crude oil and petroleum products, and chemicals, specialized components, and supporting infrastructure (water, waste water, power, communications) and essential staff.

Source of photos: California Energy Commission
Graphic from the *Oil and Natural Gas Preparedness Handbook*, American Petroleum Institute, April 2016
Examples of California Oil Supply Chain Assets

- 13 major refineries provide a majority of transportation fuel to California and neighboring states
- Several smaller refineries produce asphalt and other petroleum products
- Note: Nearly all are in earthquake hazard zones and many directly or indirectly are at risk to sea-level rise/coastal flooding and wildfires

Information and graphic provided by the California Energy Commission
Examples Of Dependencies and Interdependencies That Can Affect The Oil Supply Chain

- **Electric power**
  - For running all types of industrial and other processes, including control systems, for production, pipeline distribution, off-loading oil from tankers, etc.

- **Water**
  - For production, handle waste products, fire suppression
  - Clean water for certain processes

- **Telecommunications and IT systems**
  - For SCADA/process control systems, communications with field personnel, etc.

- **Transportation**
  - Access to all modes—road, rail, and particularly marine for transport of fuel at various points key in the oil supply chain
  - Access to terminals to receive petroleum and petroleum products by tanker, barge, pipeline, rail, or truck
  - Accessible transportation routes, including bridges with sufficient vertical access
  - Timely issuance of waivers to provide emergency fuel
Examples of Dependencies and Interdependencies Impacting the Oil Supply Chain, cont.

- **Transportation Assets**—trucks, barges, and rail tankers
  - For oil or processed fuel transport
  - To convey waste products from production or processing that need to be taken out of the facility on a regular basis for safety reasons
  - Natural gas for utility and public transportation vehicles

- **Chemicals and Additives**
  - Hydrogen and nitrogen gas, and sulfuric and other acids (some of which can only be stored in limited amounts and delivered on a just-in-time basis)
  - Ammonia
  - Additives for boutique fuels

- **Disposal of Hazardous Materials**
  - For wastewater and industrial waste (note: if onsite disposal, evacuation ponds are necessary as well as the ability to clean and discharge the treated water to the environment safely)
Examples of Dependencies and Interdependencies Impacting the Oil Supply Chain, cont.

- **Fuel storage capacity**
  - For processed fuel under normal conditions and for emergency storage

- **Natural gas**
  - For electric power generation

- **Emergency power generation**
  - For support of safe shutdown of operations

- **Essential personnel**
  - For on-site firefighting, trained truck drivers, damage inspectors, federal and state safety inspectors, etc.

- **Required equipment for safety or operations**
  - Example are fire pumps for flammable hazardous materials
  - Other specialized equipment
Considerations for Public Health and Healthcare and Oil Supply Chain Interdependencies

- Extreme storms, fire storms, and major earthquakes could directly damage, or through interdependencies cause indirect damage and disruption of fuel sector assets

- A fast moving, mass casualty toxic air emission from damage to a refinery would require rapid decision-making among many diverse organizations

- There could also be similar impacts from power loss to facilities producing or storing other highly hazardous chemicals

- Can affect hundreds to thousands of individuals and exceed hospital surge capacities with widespread impacts on essential services

Explosion and breach of elemental liquid sulfur tank at the Tesoro Refinery in Carson, CA August 26, 2016 led to a shelter-in-place order for nearby residents. (Photos above and below provided by California Department of Public Health)

Among Hurricane Harvey's devastating effects were a Crosby, TX chemical plant that lost electrical power, leading to explosions, toxic releases, and a massive fire.
Useful Actions to Advance Energy Infrastructure Resilience for Natural and other Major Disasters

What U.S. DOE and partner federal agencies can do:

- Develop a holistic approach that wraps up a number of activities underway in research, technology development, and policy into a National Energy Infrastructure Resilience Strategy with input from state, local government, and utility representatives.

The approach should:

- Include guidelines for state and local government with objectives and key capabilities needed, and sources of support to develop them.
- Incorporate energy infrastructure dependencies and interdependencies into planning and actions to operationalize resilience.
- Include “all players”, with contributions based on respective missions and responsibilities.

- Develop interdependencies analysis tools that can be used at the local level by utilities, local government planners and emergency managers to improve organizational and regional energy and broader infrastructure resilience.
Useful Actions to Advance Energy Infrastructure Resilience, cont.

- What States Can Do
  - Work with utilities, other critical infrastructures, and localities to:
    - Expand energy assurance plans to include energy infrastructure resilience for major disasters and to better understand impacts of interdependencies on electric and natural gas providers, and the oil supply chain, and the implications for response and initial restoration priorities, resourcing issues, and fuel storage requirements
    - Examine what regulations and other restrictions can exacerbate interdependencies impacts for transportation, environmental, safety and other policy constraints—federal, state, and local
    - Promote and enable cross-sector collaboration and recognition that energy infrastructure resilience is dependent on the resilience of other interdependent infrastructures and is a collective local, state, and federal effort
    - Use workshops and exercises to identify potential impacts and capability needs under different scenarios
Useful Actions to Advance Energy Infrastructure Resilience, cont.

▪ What Energy Providers Can Do
  ▪ Incorporate interdependencies into risk assessment and management
  ▪ Hold informal discussions with representatives of water systems, refineries, and other lifelines to discuss mutual interdependencies
  ▪ Collaborate with public-private resilience-focused coalitions to contribute to energy infrastructure and broader resilience planning and identify energy infrastructure resilience mitigation actions
  ▪ Participate in regional interdependencies exercises to illuminate impacts and gaps

▪ What All Players Can Do Collectively
  ▪ Examine what other regions and individual stakeholders are doing—solutions and “best practices”—and leverage/customize what is useful
  ▪ Assist in developing and participating in cross-sector information sharing to identify essential data necessary for improved resilience
High Importance of Cross-Sector Information Sharing for Energy and Broader Infrastructure Resilience

- Essential for assessing interdependencies-related risk, event situational awareness, and better estimating interdependent infrastructure restoration timelines and decision-making

- Provides timely information on:
  - Status of damages to roads, bridges, and rail lines, including determining priority routes, which will affect access of restoration crews and movement of petroleum product out of refineries
  - Availability of key resources, including damage assessment and repair personnel; repair materials, equipment, and system components; emergency fuel; and environmental and regulatory waivers
  - Status and estimated duration of power outages
  - etc.
Example of Cross Sector Information Sharing for Interdependencies-Related Risks

- Development of a Cross-Sector Information-Sharing System of Systems for counties, cities and special districts, utilities, and non-profit and business entities

- Initiative is a regional collaborative effort by a Core Team of representatives of 16 organizations with a Stakeholder Group of more than six dozen organizations and associations

- Funded by U.S. Department of Homeland Security Infrastructure Protection as one of 10 projects selected nationwide in the 2016 National Infrastructure Protection Plan (NIPP) Challenge competition
InfoXchange—Gateway & Hub for Sharing Cross-Sector Information

Data for enhanced planning and response/recovery coordination

Secure Information and data sharing using various formats and applications

Access to tools/resources for improving resilience

Tools for updating/sustaining member information and contacts
Existing and Potential Community of Interest Dashboards Comprising InfoXchange
Example of Resilience Tool: EPRI’s Standardized Approach for Publishing Outage Information

**Opportunities:**

- Timely, Accurate Outage Information for Key Stakeholders
- Provides a level of detail to allow local government and utilities to make intelligent decisions
- Can be tailored for emergency managers, critical agencies, hospitals, city or county managers

Electric Utilities

**InfoXchange**

Summary Data

Detailed Data

**XchangeCore**

Public Outage Maps  Smart Cities / Municipalities  Consistent reporting to media outlets (TV, Radio)

**Emergency Management**

Local/County/State Agencies and First Responders  Federal Agencies (DoE, FEMA, DHS, HHS)

Information and Graphics provided by the Electric Power Research Institute
For Further Information

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Empowering Collaborative Action to Build Resilient Communities and Regions