Linking QER 1.1 and 1.2

QER 1.1

Transmission Lines
765, 500, 345, 230 and 138 kV

Distribution Lines

Subtransmission Customer
26kV and 69kV

Primary Customer
13kV and 4kV

Secondary Customer
120V and 240V

Fuels
Generating Station
Generator Step-Up Transformer

Waste

Transmission Customer
138 kV or 230 kV

Substation Step-Down Transformer

QER 1.2

Generation  Transmission  Distribution  Customers
QER 1.1: 63 Recommendations

- Increasing Resilience, Reliability, Safety and Asset Security
- Modernizing the Electric Grid
- Modernizing US Energy Security Infrastructure
- Shared Transportation
- Integrating N. American Energy Markets
- Workforce
- Siting and Permitting
QER 1.1: Implementation

Implementation Breakdown:
- Executive Action
  - Existing authorities – 43
- Legislative Action (Congress)
  - New appropriation – 13
  - New statute – 10

Highlights:
- 12 recommendations are complete
- 21 recommendations are reflected in law following Congressional action
- $2 billion to modernize the Strategic Petroleum Reserve

QER 1.1 Implementation Report Card
- Provides detailed analysis of the QER’s 63 recommendations
- Assesses progress achieved in the time following the QER’s release
- Determines what additional actions are required for implementation to occur
QER 1.1 documented major transformation of Electricity Sector:

- Changing generation mix
- Low load growth
- Increasing vulnerability to severe weather/climate
- New technologies, services and market entrants
- Cyber/physical threats
- Aging infrastructure and workforce
- Growing overlap between jurisdictions

Given the centrality of electricity to the Nation, this transformation merits a closer examination in the next installment of the QER.
The QER 1.2 Focus

- QER 1.2 will analyze how the electric power system as a whole is evolving, including:
  - Integrating new technologies
  - Changing market conditions
  - Grid operations
  - Financing and valuing
  - Changing role of the customer
  - Jurisdictional challenges

- Physical structures and the roles of a range of actors, institutions and industries:
  - Maintaining reliability of supply
  - Ensuring electricity affordability
  - Adapting to dramatic changes in technology and services
  - Fuel choice
  - Distributed and centralized generation
  - Physical and cyber vulnerabilities
  - Federal, state, and local policy direction
  - Expectations of residential and commercial consumers
  - Reviewing existing and evolving business models for a range of entities, throughout the system
Stakeholder Process

Stakeholder Meetings: energy.gov/qer

- State-Tribal QER Listening Sessions: NARUC, NASEO, NCSL, STEAB, ICEIWG
- Public Comments
National Academies Workshop: 
Electricity Use in Rural, Isolated and Islanded Communities 
February 2016

- Incorporating efficiency
- Increasing resilience, reliability
- Rate design
- Generation alternatives for CO2 reduction
- Technology and operational innovation
- Modernization of planning paradigm
- Transportation linkages to electricity system
- Microgrids

FIGURE 3 As of 2015, the Alaska Village Electric Cooperative serves more than 50 small communities dispersed across large distances and in remote regions with harsh climatic conditions. All of these factors contribute to average electricity prices approximately 5 times the U.S. national average. SOURCE: Modified from Meera Kohler, Alaska Village Electric Cooperative, “Alaska Village Electric Cooperative,” presentation to the workshop, February 8, 2016.
### Energy Policy Innovation Consortium: State Policy Actions

*State Policy Actions from 2008- June 2016*

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<th>Categories:</th>
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<td>All actions are considered &quot;completed&quot; unless noted.</td>
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<td>- Clarify storage’s treatment in the state utility regulatory process</td>
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**Resources for Timely Answers to Analytical Questions**
New York (38), Virginia (36), Oregon (35), California (34) and Maryland (30) have the most legislation, incentives, and policy directed at clean energy economic development.
Breakdown of Alternative Energy References by State and Proportion of Municipalities by State to Reference at least One Alternative Energy Keyword
State, Local, and Tribal Products

Front-Line Resilience Perspectives

Figure 4. Key Hazards and Vulnerabilities: Electric Power Distribution*

- Thunderstorms, tornadoes, and hurricane-force winds
- Storm surges, flooding, and increased precipitation
- Earthquakes
- Physical attacks
- Aging infrastructure
- Ice, snow, and extreme cold weather
- Increasing temperature and extreme hot weather
- Cyber attacks
- Geomagnetic and Electromagnetic Pulses
- Capacity constraints
- Dependencies and supply chain interruptions

Electricity received from Transmission system

Distribution substation transformers step down voltage for distribution

Distribution poles and lines carry electricity to end users

Distribution control center monitors and manages local electricity

- Cyber attacks
- Human error
- Workforce turnover and loss of institutional knowledge

Local transformers step down voltage before it reaches the end user

Electricity transmitted to Consumers
State Energy Resilience Framework

RESILIENCE – Ability of an entity – e.g., asset, organization, community, region – to anticipate, resist, absorb, respond to, adapt to, and recover from a disturbance.

Includes Case studies for:
- New York – Fuel New York
- California – Substations
- Oregon – Cascadia Fault
Electricity Emergency Response Capabilities

Figure 1: Local/Regional/National Restoration Escalation Process
Policy Drives Generation Capacity Additions

Additions (GW) by Fuel Type, 1950-2015

- Coal
- Natural Gas
- Petroleum
- Biomass
- Nuclear
- Hydro
- Wind
- Solar
- Geothermal
- Other

Key Events:
- DOE Org Act 1977
- PTC for Wind
- ITC for Solar 2006
- Price-Anderson Act 1957
- Fuel Use Act Repeal 1980
- ARRA 2009

21 states enact Renewable Portfolio Standards
Renewables Capacity Increasing, Costs Declining...

**Distributed Solar, 2008-2013:** 
769% increase in capacity

**Utility Scale Solar PV & Thermal, 2008-2013:** 
1200% increase in capacity

**Utility Scale Wind, 2008-2013:** 
245% increase in capacity

Sources: Department of Energy, Office of Energy Efficiency and Renewable Energy analysis, GTM, SEIA, LBNL, NREL
Top 10 Solar Generation States

Distributed solar PV installed capacity, top 10 states, as of September 2015
megawatts (MWAC)

- California: 3,057
- New Jersey: 793
- Arizona: 609
- Massachusetts: 507
- New York: 379
- Hawaii: 358
- Colorado: 243
- Maryland: 208
- Pennsylvania: 147
- Connecticut: 129
- Rest of U.S.: 1,261

Source: Energy Information Administration, September 2015
About 43 GW of capacity currently under construction in the United States (as of May 2016)

**US capacity under construction: 43 GW**

- **Gas CC**: 53%
- **Wind**: 18%
- **Solar**: 9%
- **Nuclear**: 13%
- **Gas CT**: 6%
- **Other**: 1%

**US capacity under construction by region**

- **PJM**
- **Southeast**
- **ERCOT**
- **Mid-Continent**
- **West**
- **Northeast**

Source: IHS and ABB Velocity Suite © 2016 IHS
U.S. Power Plant Retirements, 1995-2025

1996–05:
Coal retirements: 4 GW
Total retirements: 36 GW

2006–15:
Coal retirements: 43 GW
Total retirements: 98 GW

2016–25:
Coal retirements: 43 GW
Total retirements: 90 GW

Capacity Additions, 1995-2025

Notes: Additions exclude coal-to-natural gas or biomass conversions.
Source: IHS and ABB Velocity Suite
Distributed Energy Storage

- From an end-use perspective, distributed electricity storage can reduce peak load and facilitate adoption of distributed generation.

- Continued decreases in storage technology costs, driven by greater production of batteries for electric vehicles and state-level storage mandates, are likely to increase distributed storage growth.

Rates Vary by Class and Utility Type

- Generation is by far the largest component of retail rates.
- Industrial customers typically pay the lowest rates, partially determined by cost differentials, but also by policy goals such as economic development or income-rate progressivity.
- Rates for public utilities are slightly lower than those of IOUs for residential and commercial customers, but higher for industrial customers.
- Averaged across consumer classes, IOUs have higher rates than municipal and cooperative utilities. IOUs are for profit entities and include profits as an additional cost.
Lifeline Network Interdependencies

- **Oil**
  - Power for Pumping Stations, Storage, Control Systems
  - Fuel for Generators, Lubricants
  - Fuel Transport, Shipping

- **Electricity**
  - Power for Switches
  - Power for Pumping Stations, Storage, Control Systems
  - Fuel for Generators

- **Gas**
  - Power for Compressors, Storage, Control Systems
  - Fuel Transport, Shipping

- **Telecom**
  - SCADA Communications

- **Water**
  - Water for Cooling, Emissions Reduction
  - Water for Production, Cooling, Emissions Reduction

- **Shipping**
  - Fuel Transport, Shipping

- **Heat**
  - SCADA Communications

- **Fuel for Generators, Lubricants**

- **Water for Cooling, Emissions Reduction**

- **Fuel for Generators, Lubricants**

- **SCADA Communications**

- **Fuel for Generators**

- **Fuel for Generators, Lubricants**

- **Water for Cooling, Emissions Reduction**

- **SCADA Communications**

- **Fuel for Generators, Lubricants**

- **Water for Cooling, Emissions Reduction**

- **SCADA Communications**
Figure 6: The Growth of Data in the Power Industry

Source: EPRI, GTM Research

SOURCE: GTM RESEARCH
50 Million Installed Smart Meters

Value of Smart Grid Technology

- Efficiency
- Reliability
- Cost reduction
- Customer empowerment
- Outage recovery

Obstacles to Smart Grid Technology Adoption

- Tech immature
- Funding
- Customer resistance
- Internal expertise

First Most Important | Second Most Important | Third Most Important
Smart grid will rely on processing exponentially more data at exponentially faster speeds.
The smart grid’s evolution is reliant on the build out of the Internet of Things infrastructure.
Policy Implications of Smart Grid

- **Opportunities** More efficient use of infrastructure
- **Opportunities** Development of innovative services
- **Challenges** Expansion of attack surfaces
- **Challenges** Changing privacy concerns
- **Uncertainties** Impact on electricity demand
- **Uncertainties** Increasing interdependencies vs. Increasing resilience to N-1
- **Uncertainties** Changing employment opportunities