QUADRENNIAL ENERGY REVIEW

QER 1.1 and1.2

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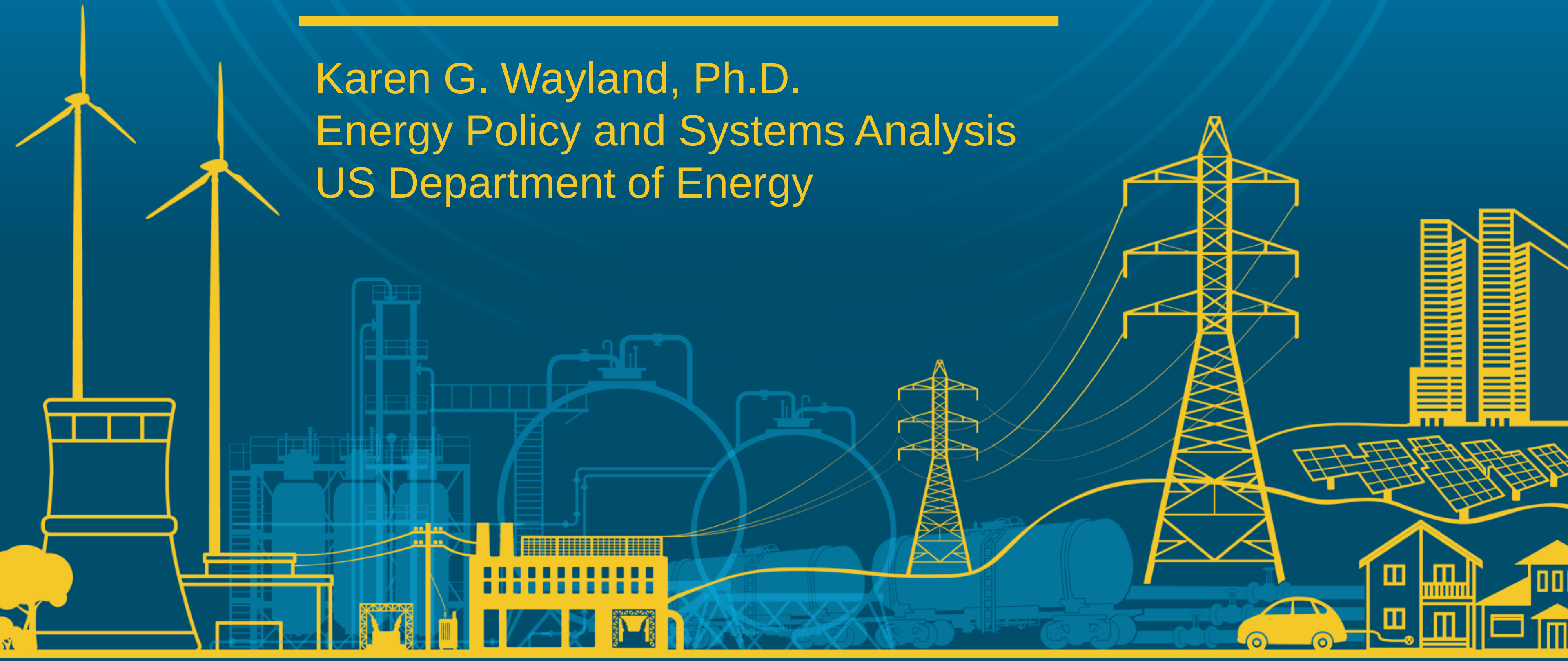
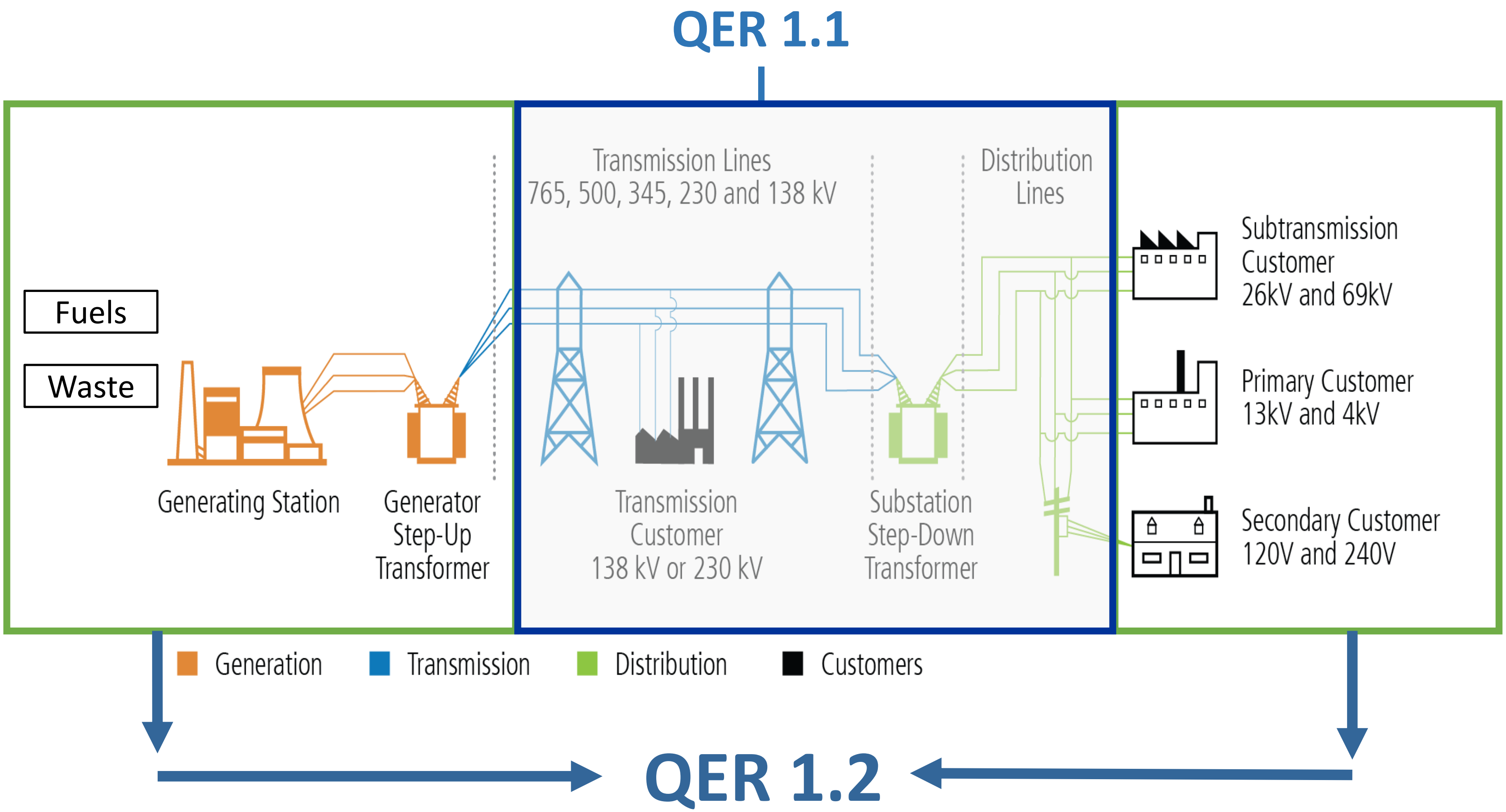


RPS Summit

November 30, 2016 | Washington, DC

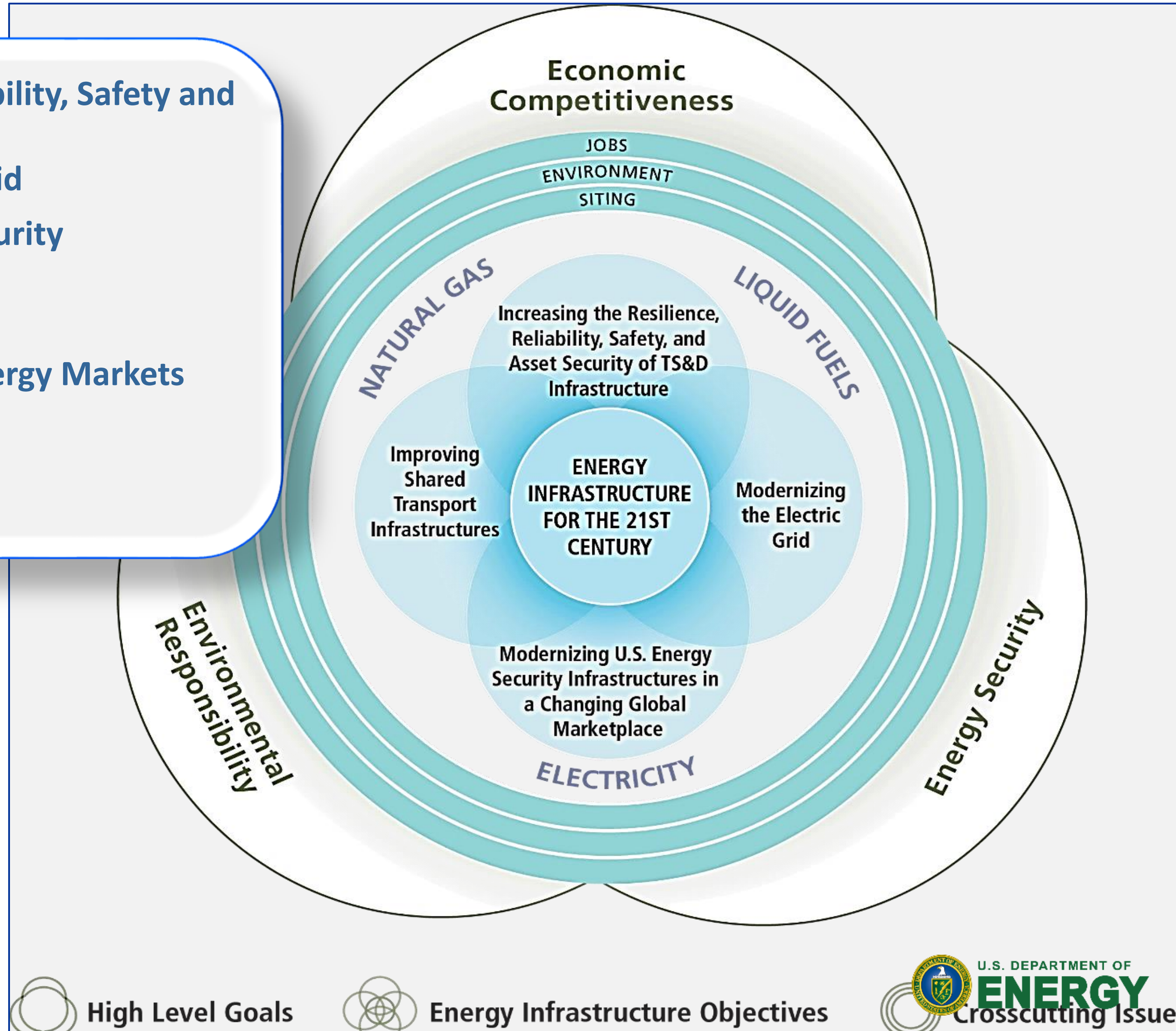
Linking QER 1.1 and 1.2



U.S. DEPARTMENT OF ENERGY

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



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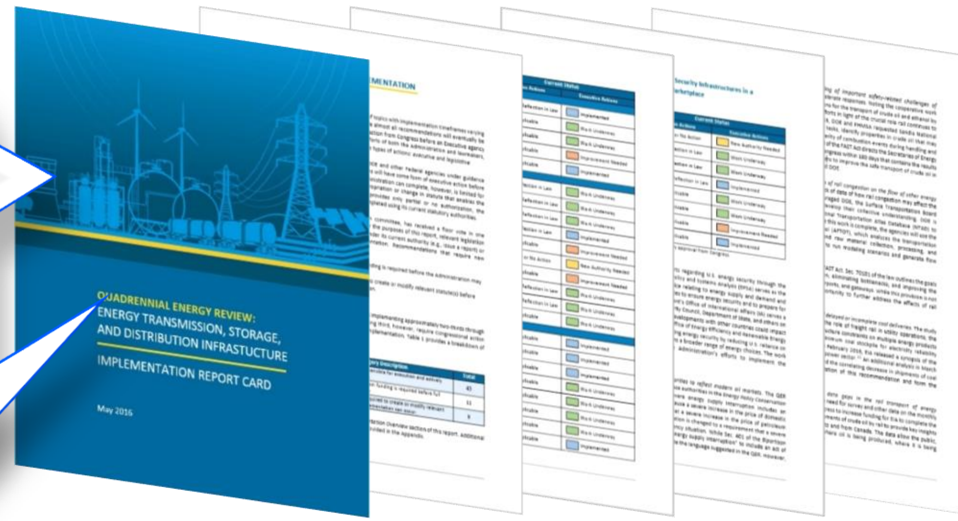
QER 1.1: Implementation



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

U.S. DEPARTMENT OF ENERGY

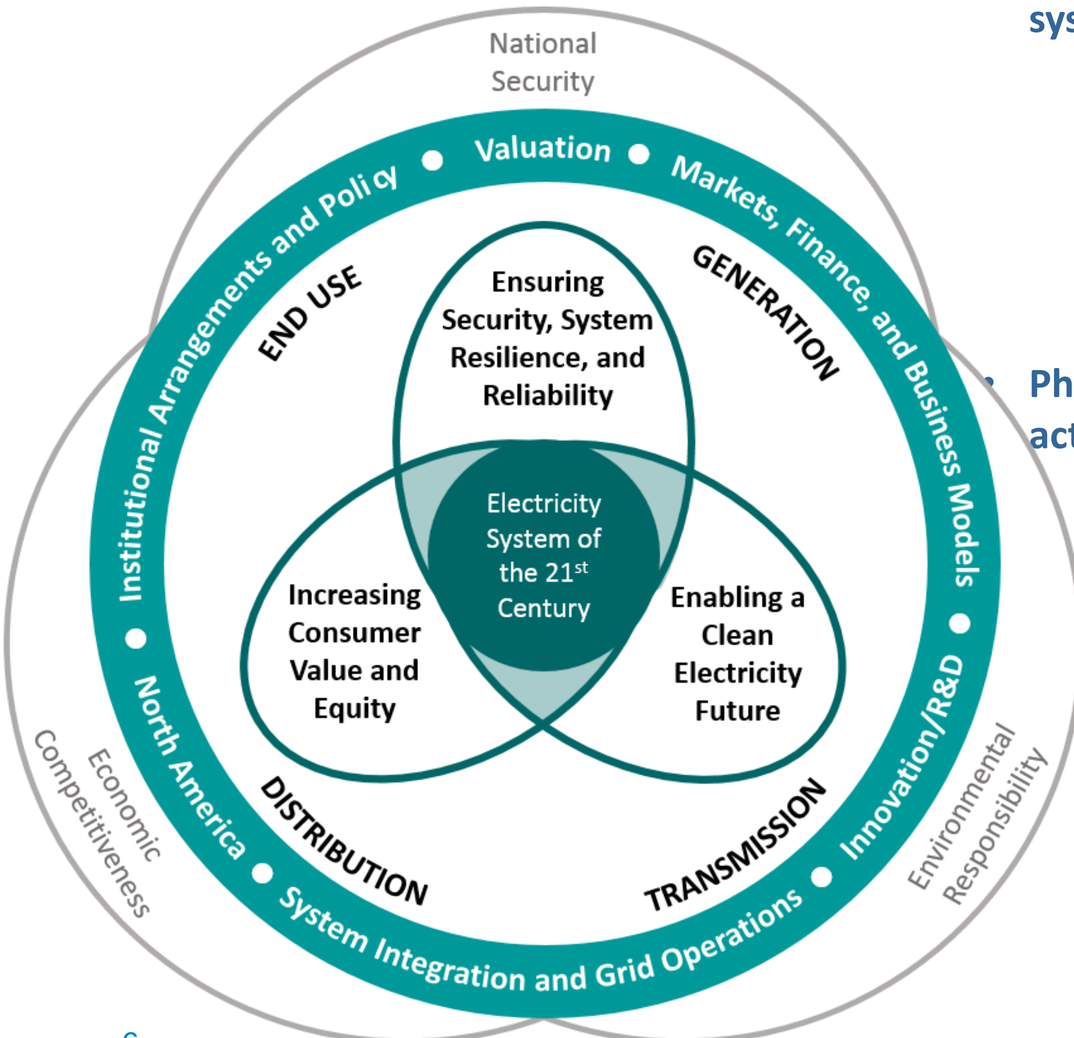
QER 1.2: Electricity Generation to End Use

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

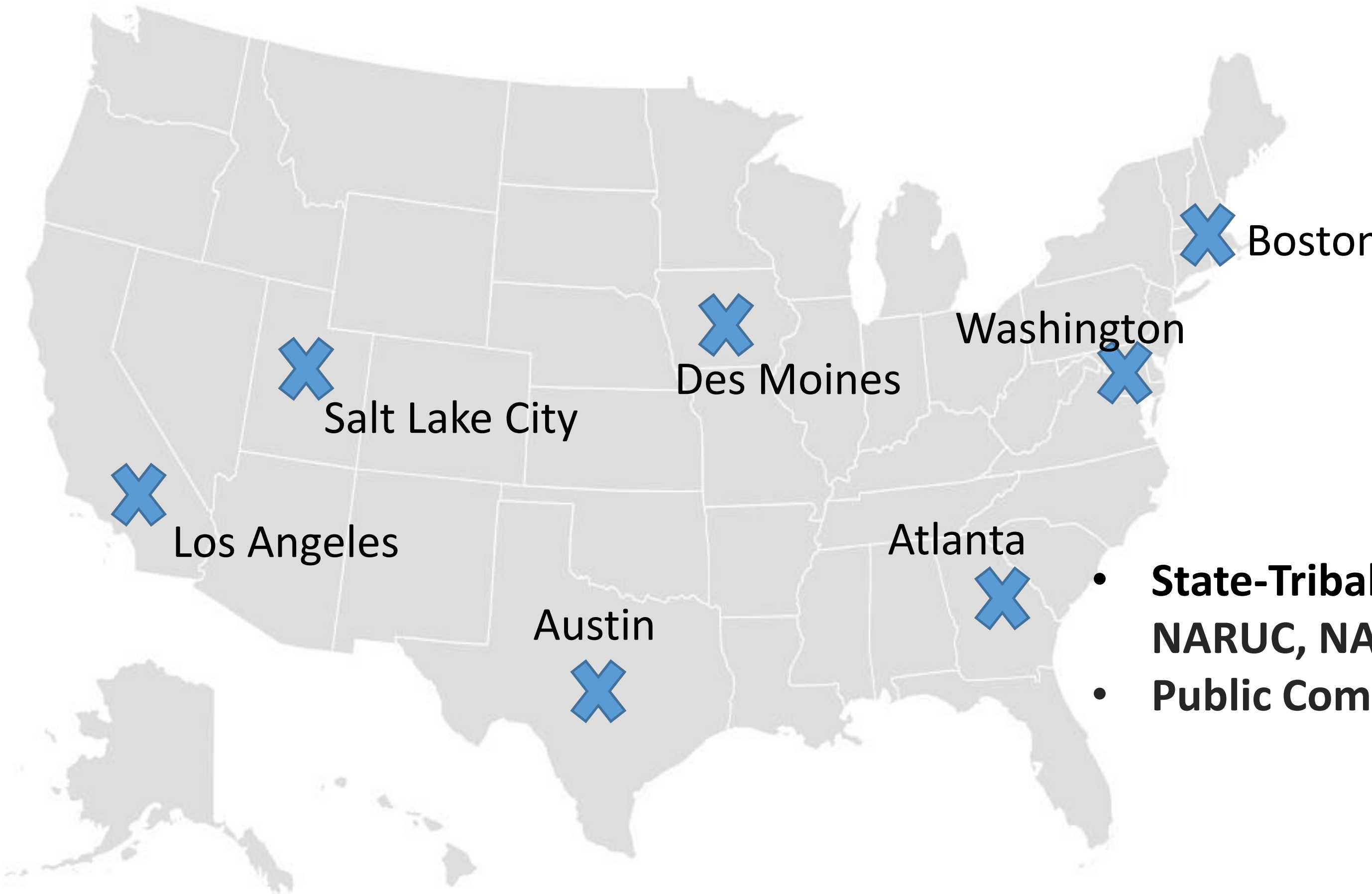


- **QER 1.2 will analyze how the electric power system as a whole is evolving, including:**
  - Integrating new technologies
  - Changing market conditions
  - Grid operations
  - Financing and valuing
  - Changing role of the customer
  - Jurisdictional challenges

- **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

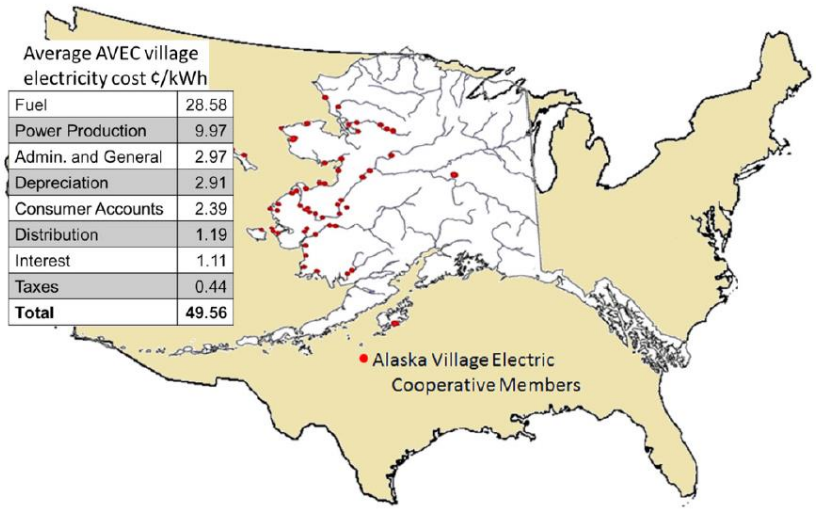
Stakeholder Meetings: energy.gov/qer



- **State-Tribal QER Listening Sessions: NARUC, NASEO, NCSL, STEAB, ICEIWG**
- **Public Comments**

State, Local, and Tribal Products

National Academies Workshop:
Electricity Use in Rural, Isolated and Islanded Communities
February 2016



Average AVEC village electricity cost ¢/kWh

Fuel	28.58
Power Production	9.97
Admin. and General	2.97
Depreciation	2.91
Consumer Accounts	2.39
Distribution	1.19
Interest	1.11
Taxes	0.44
Total	**49.56**

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.

- 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

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State, Local, and Tribal Products

Resources for Timely Answers to Analytical Questions

Energy Policy Innovation Consortium: State Policy Actions

State Policy Actions from 2008- June 2016

Categories:

Electricity Rate Design for Clean Energy

- Decoupling
- Lost Revenue Adjustment Mechanisms (LRAM)
- Net-metering and Stand-by Rates
- New Solar Tariff
- Straight Fixed Variable Rates
- Performance Based Regulation (includes NY, HI, more comprehensive efforts)
- Performance Incentives for energy efficiency

Energy System Resilience

- State Resiliency Plans
- Energy Assurance Plans
- Cybersecurity Efforts

Energy Transmission and Distribution

- Smart Grid Initiatives
- Microgrid Development
- Transmission Planning and Siting
- Interconnection Standards

Energy Storage

- Incorporate Storage into State Energy Resilience Planning
- Require Utility Procurement of Energy Storage Capacity
- Clarify storage's treatment in the state utility regulatory process
- Incorporate storage into energy assurance efforts
- Promote research and development of energy storage

Policy Levers:

- Gubernatorial Actions
- Legislative Actions
- Agency Actions

All actions are considered "completed" unless noted.

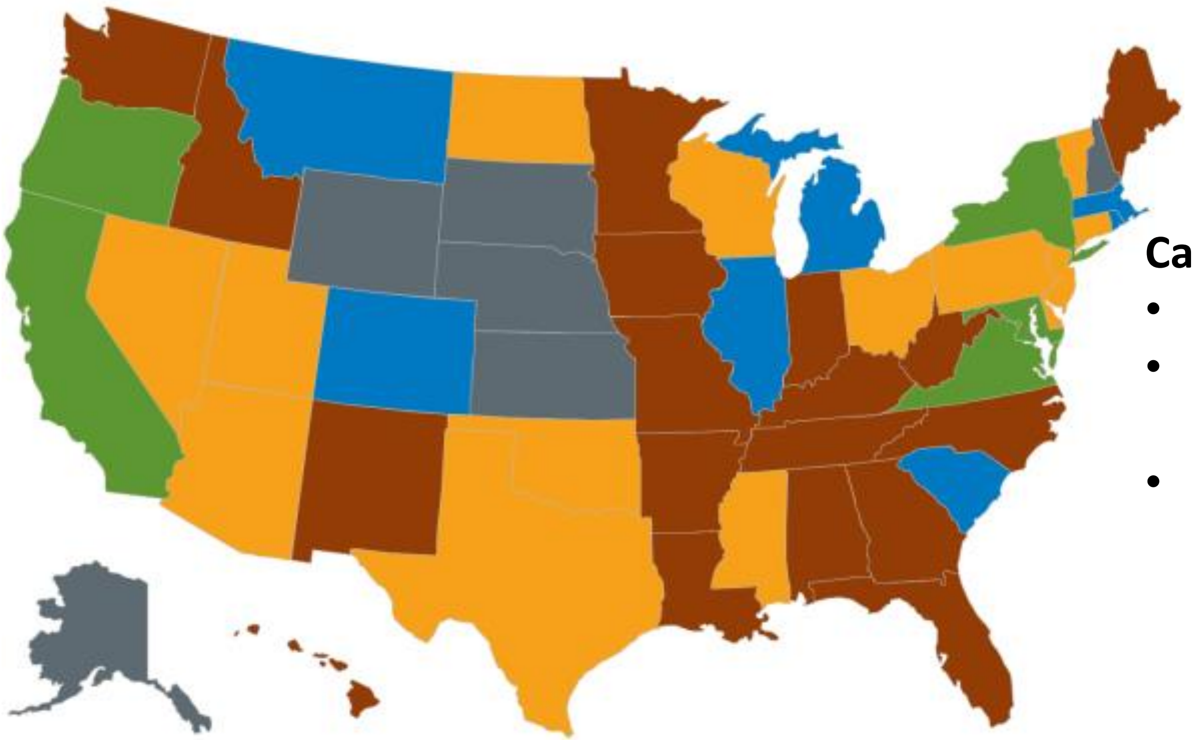
Does not include proposed legislation or proposed regulations

Resources:

- State Clean Energy Actions Database
- NCSL (Energy & Environmental and CPP Reactions)
- F&C stories (published and internally pitched)
- States' press release pages
- Executive Orders
- NASEO state news stories
- Public Utilities Fortnightly
- E&E newsletters
- ACEEE database
- DSIRE database

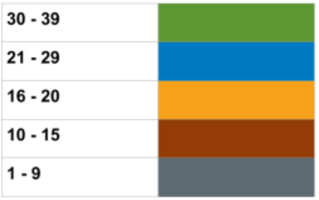
State, Local, and Tribal Products

Establishing the Playing Field: Surveying Clean Energy-related Economic Development Policy across the States



Case Studies:

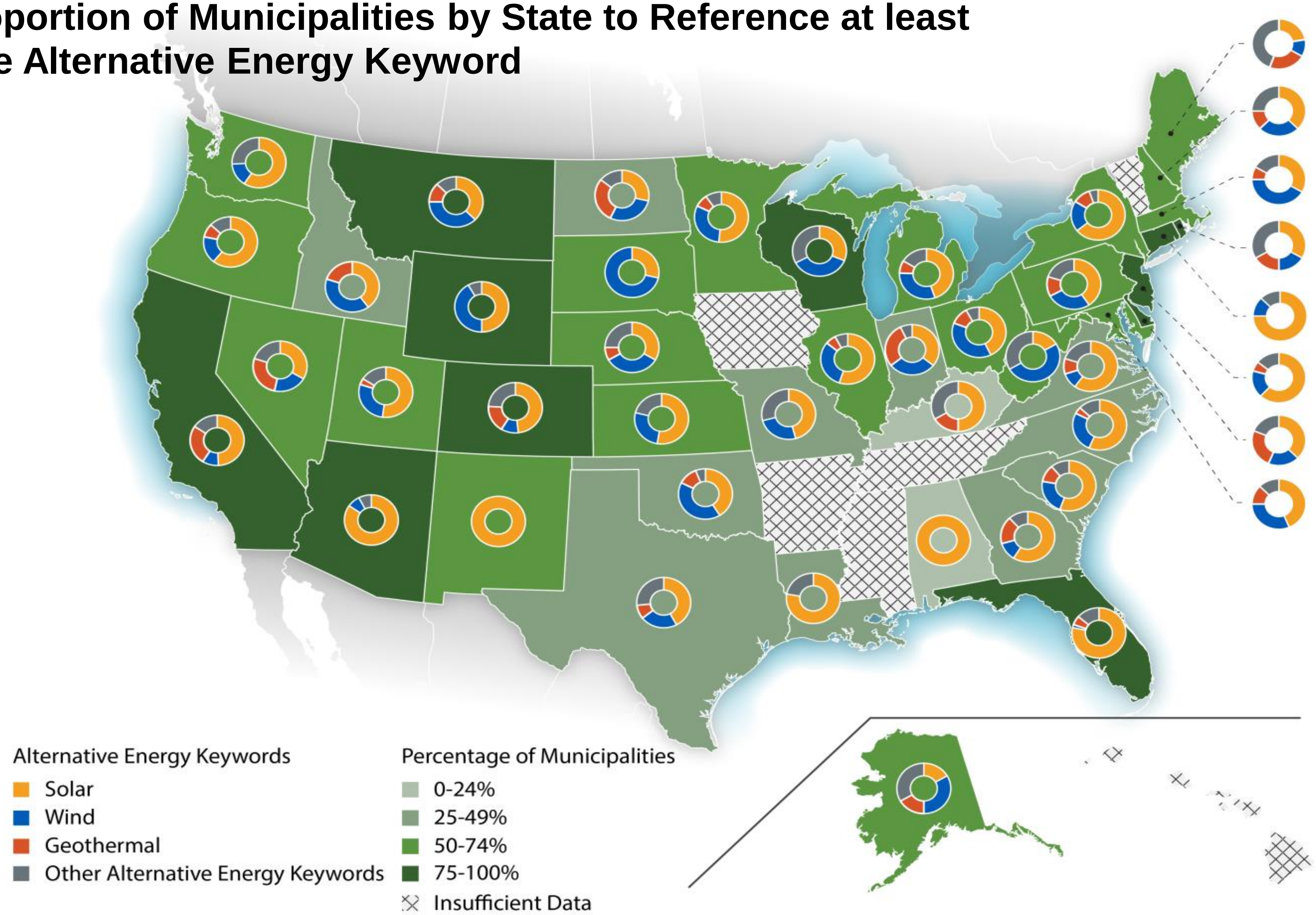
- Nevada GigaFactory
- Oregon Pacific Northwest Manufacturing Partnership
- Maryland Clean Energy Center



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.

State, Local, and Tribal Products

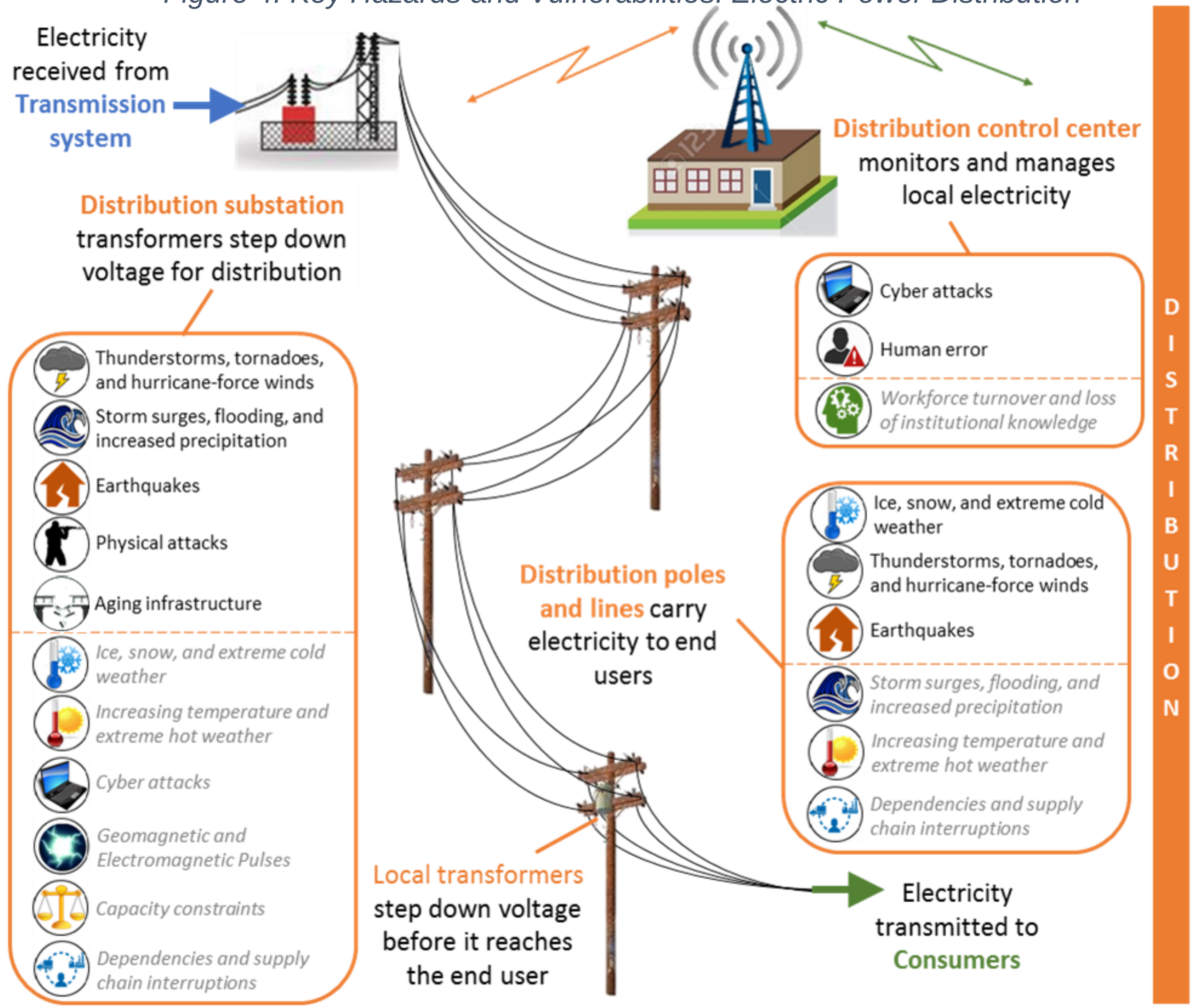
Breakdown of Alternative Energy References by State and Proportion of Municipalities by State to Reference at least One Alternative Energy Keyword



State, Local, and Tribal Products

Front-Line Resilience Perspectives

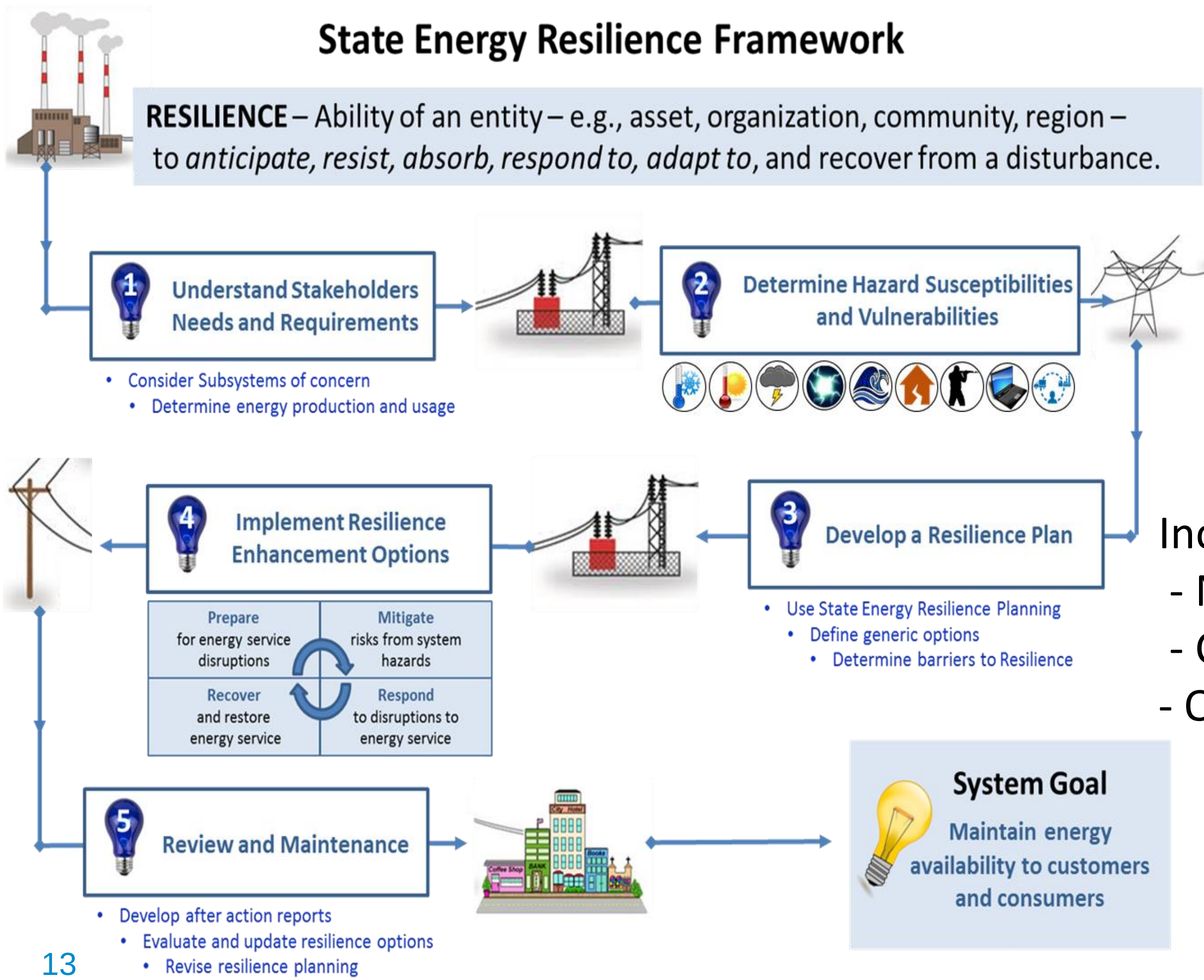
*Figure 4. Key Hazards and Vulnerabilities: Electric Power Distribution**



State, Local, and Tribal Products

Principles and Frameworks for State Energy Resilience (w/ Case Studies)

Figure 2. Proposed State Energy Resilience Framework



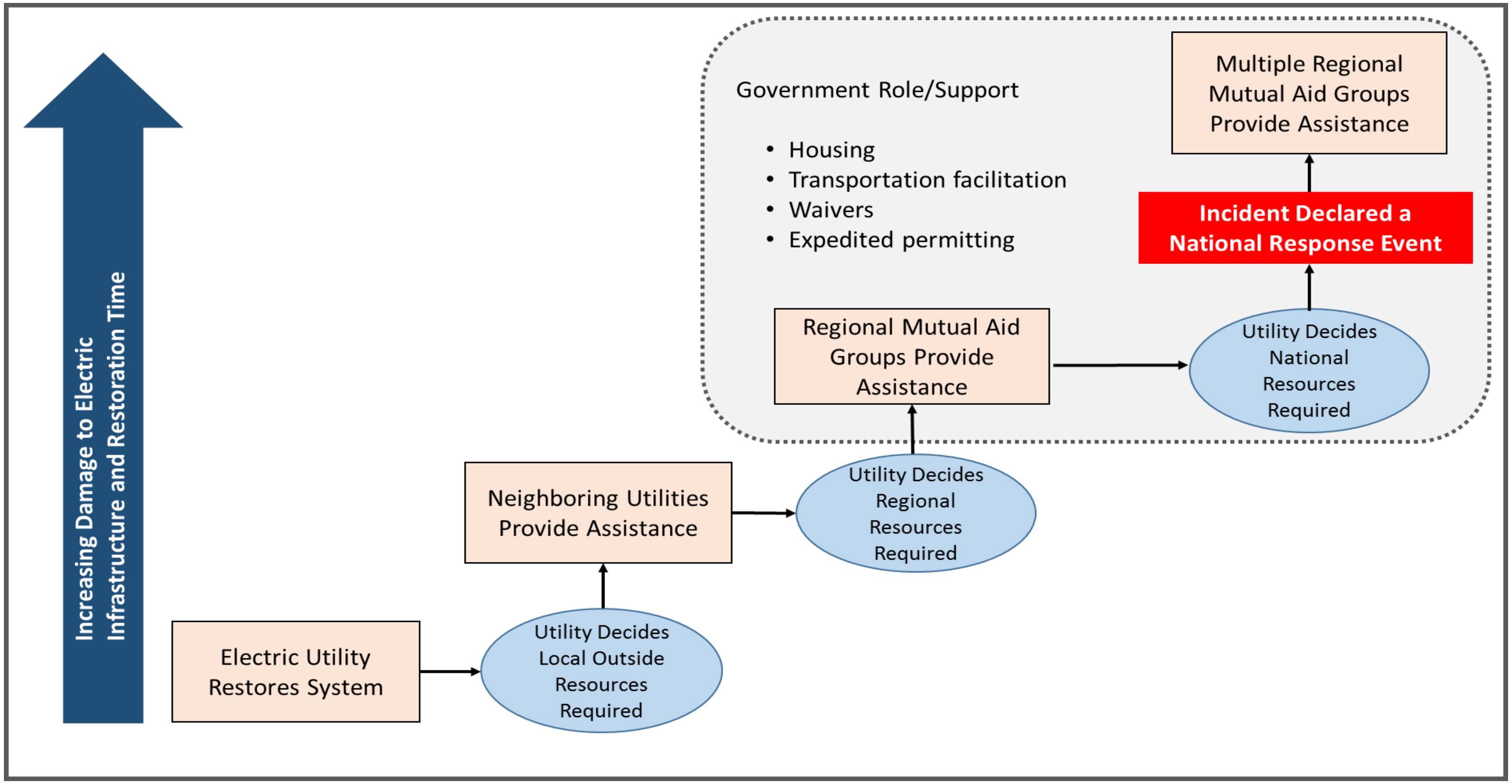
Includes Case studies for:

- New York – Fuel New York
- California – Substations
- Oregon – Cascadia Fault

State, Local, and Tribal Products

Electricity Emergency Response Capabilities

Figure 1: Local/Regional/National Restoration Escalation Process



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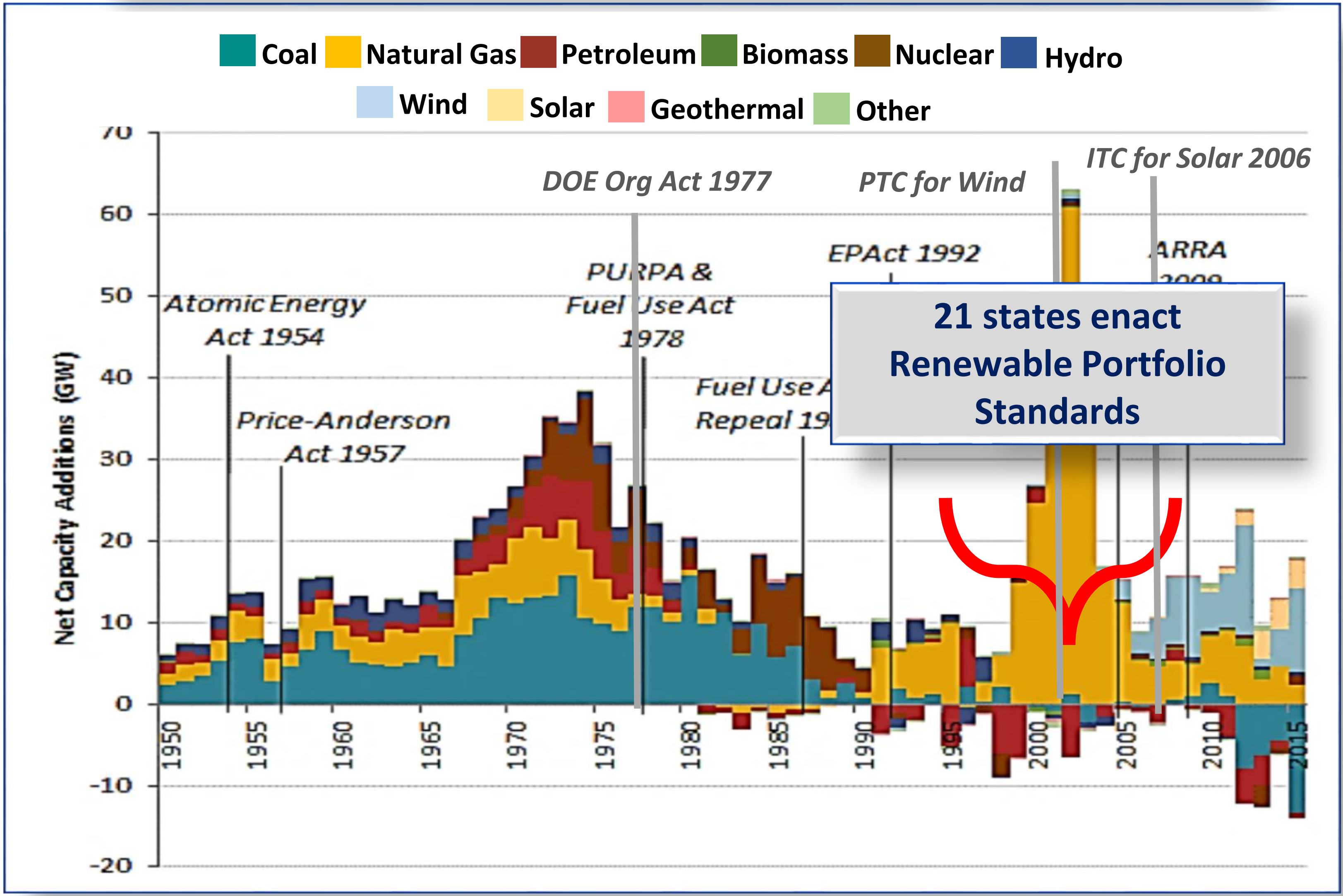
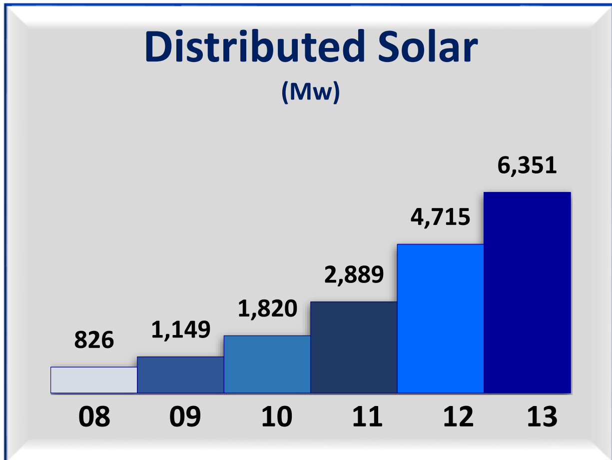
Policy Drives Generation Capacity Additions

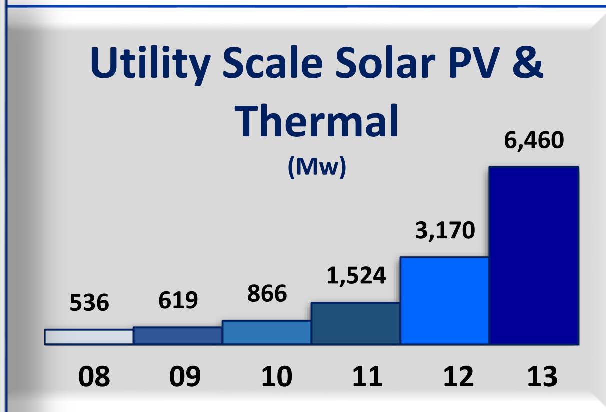
Additions (GW) by Fuel Type, 1950-2015



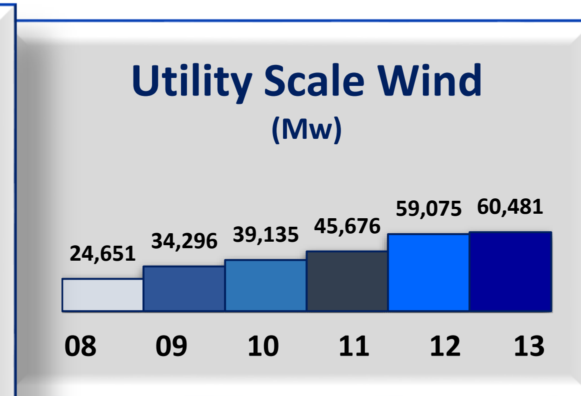
Renewables Capacity Increasing, Costs Declining...



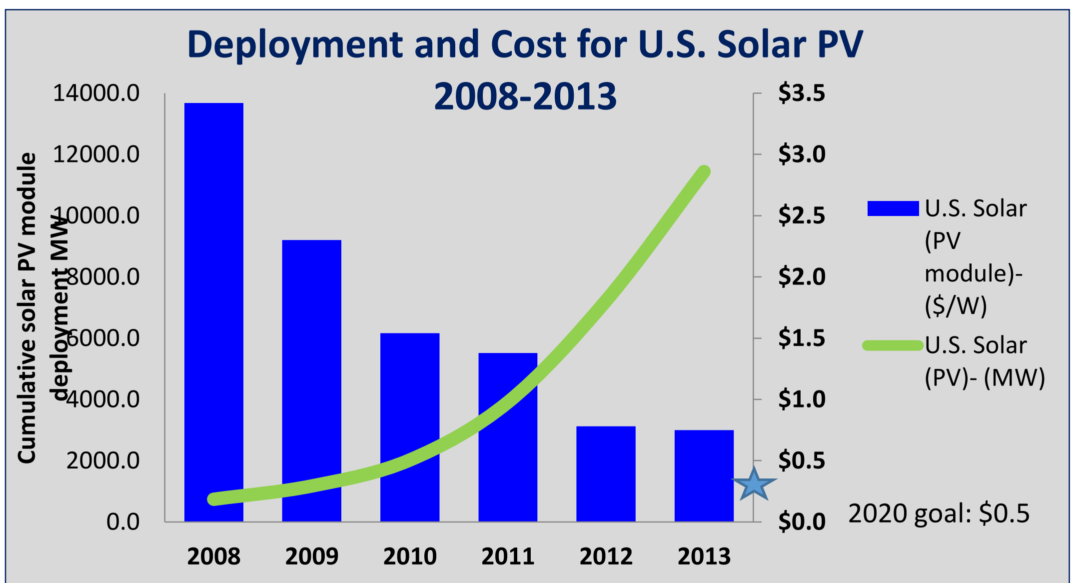
Distributed Solar, 2008-2013 :
769 % increase in capacity



Utility Scale Solar, 2008-2013 :
1200 % increase in capacity

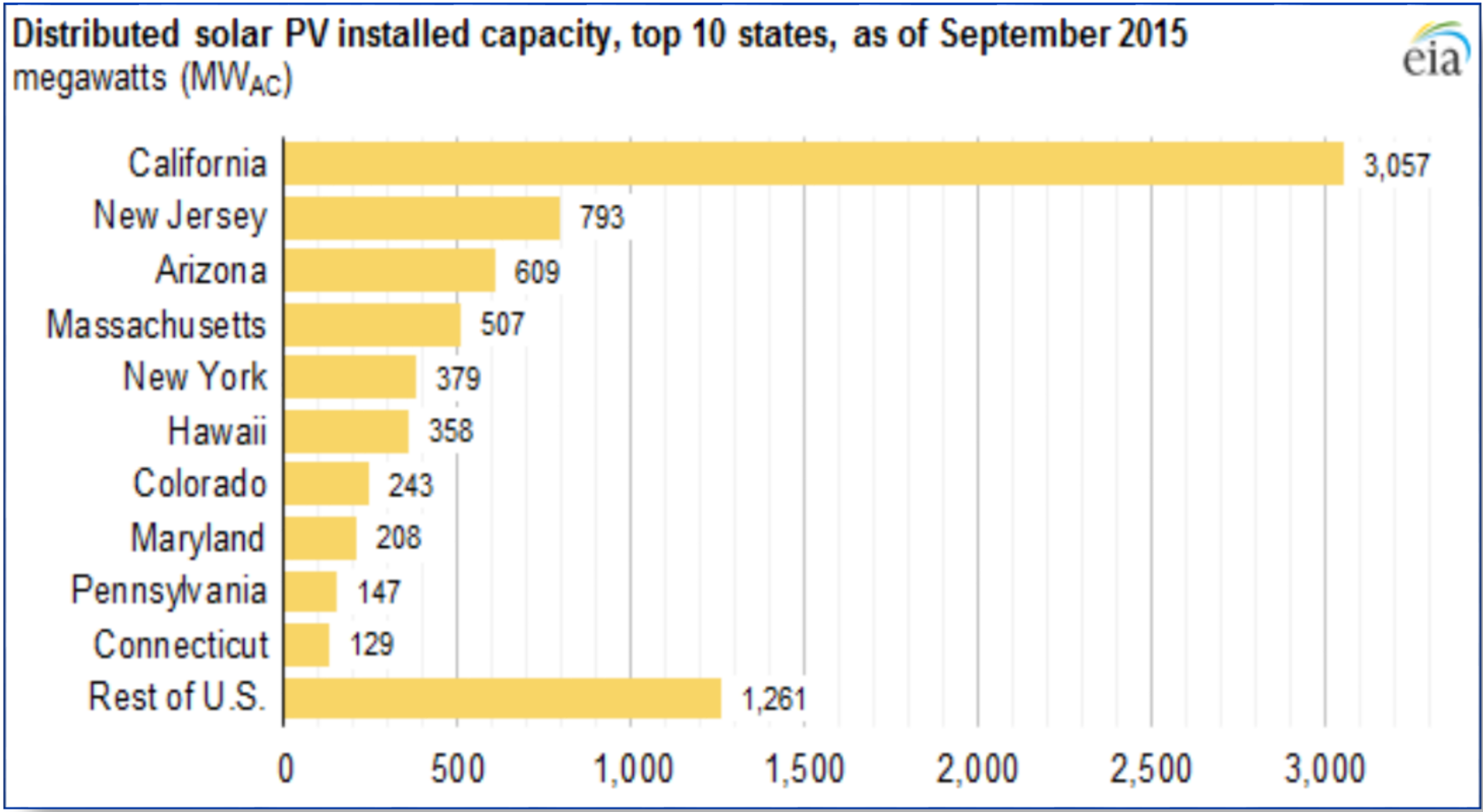


Utility Scale Wind, 2008-2013 :
245 % increase in capacity



Sources: Department of Energy, Office of Energy Efficiency and Renewable Energy analysis, GTM, SEIA, LBNL, NREL

Top 10 Solar Generation States

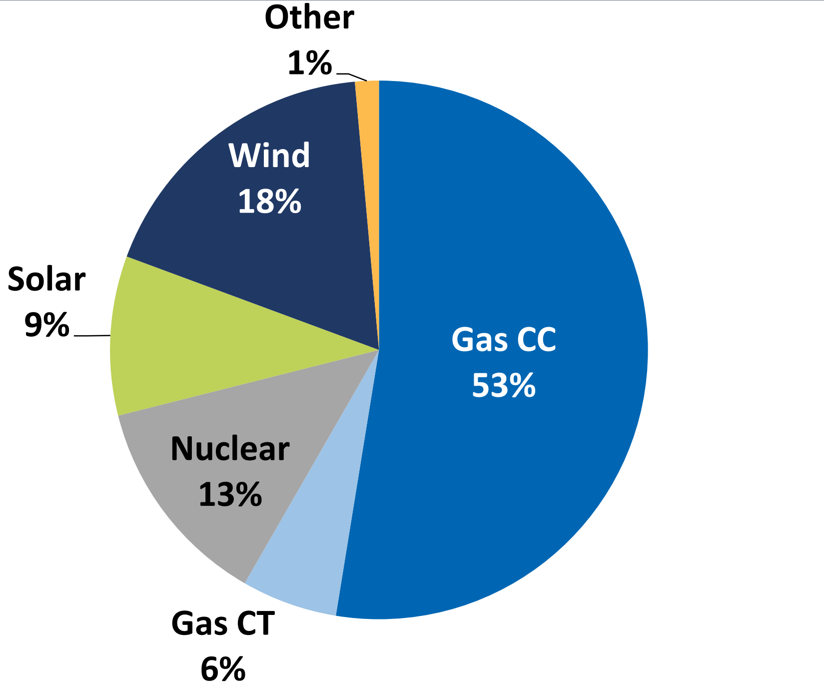


Source: Energy Information Administration, September 2015

Generation Capacity Under Construction

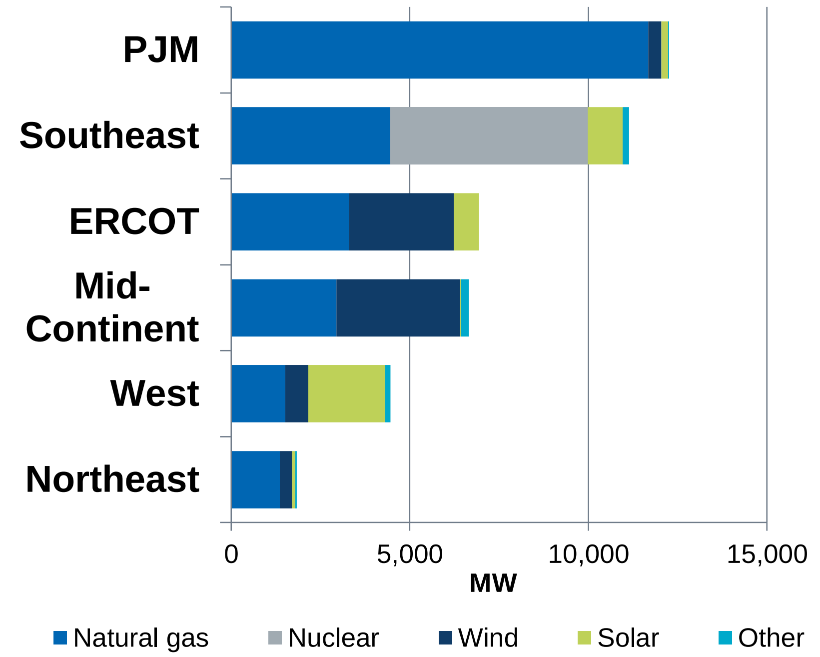
About 43 GW of capacity currently under construction in the United States (as of May 2016)

US capacity under construction: 43 GW



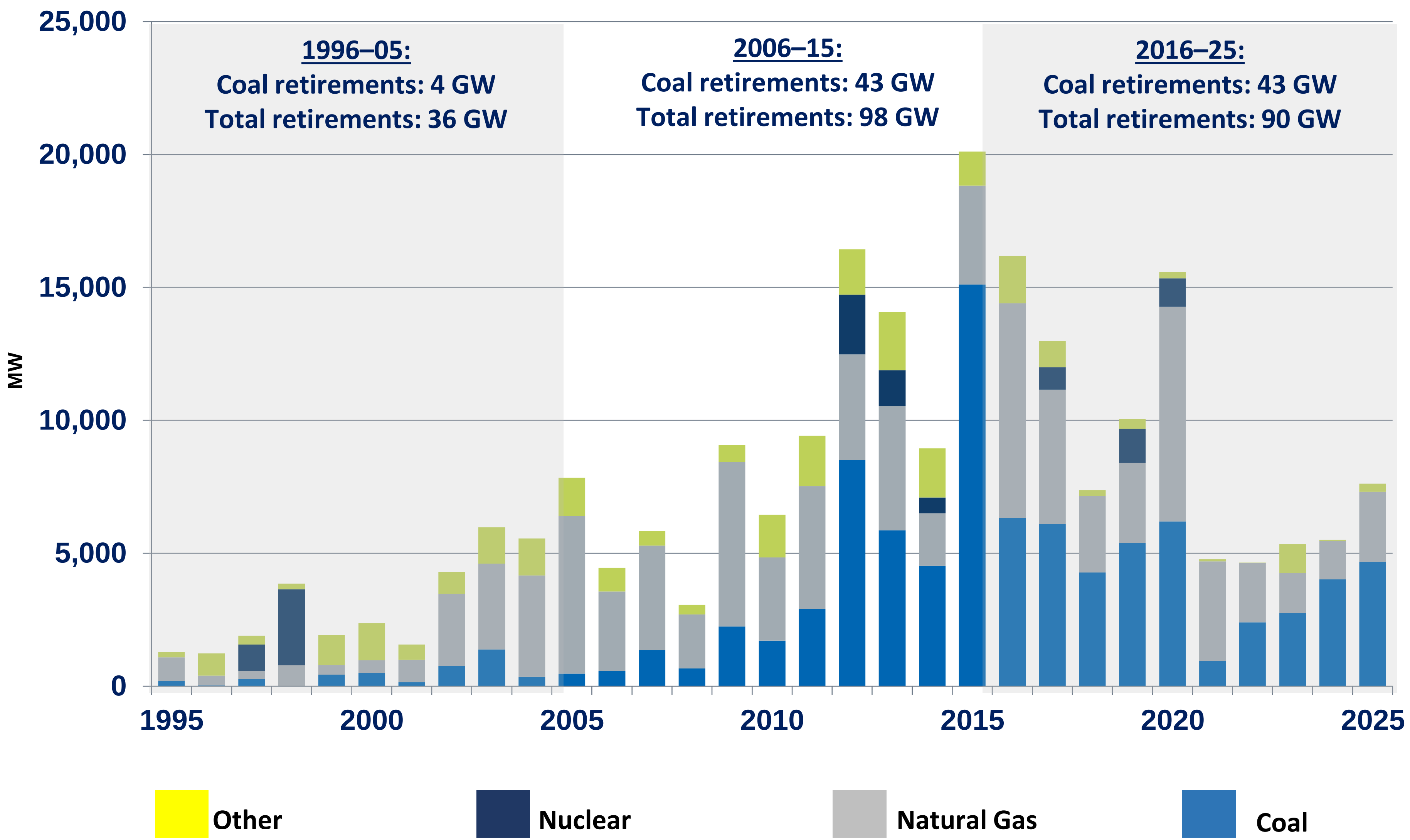
Source: IHS and ABB Velocity Suite

US capacity under construction by region



Source: IHS and ABB Velocity Suite

U.S. Power Plant Retirements, 1995-2025



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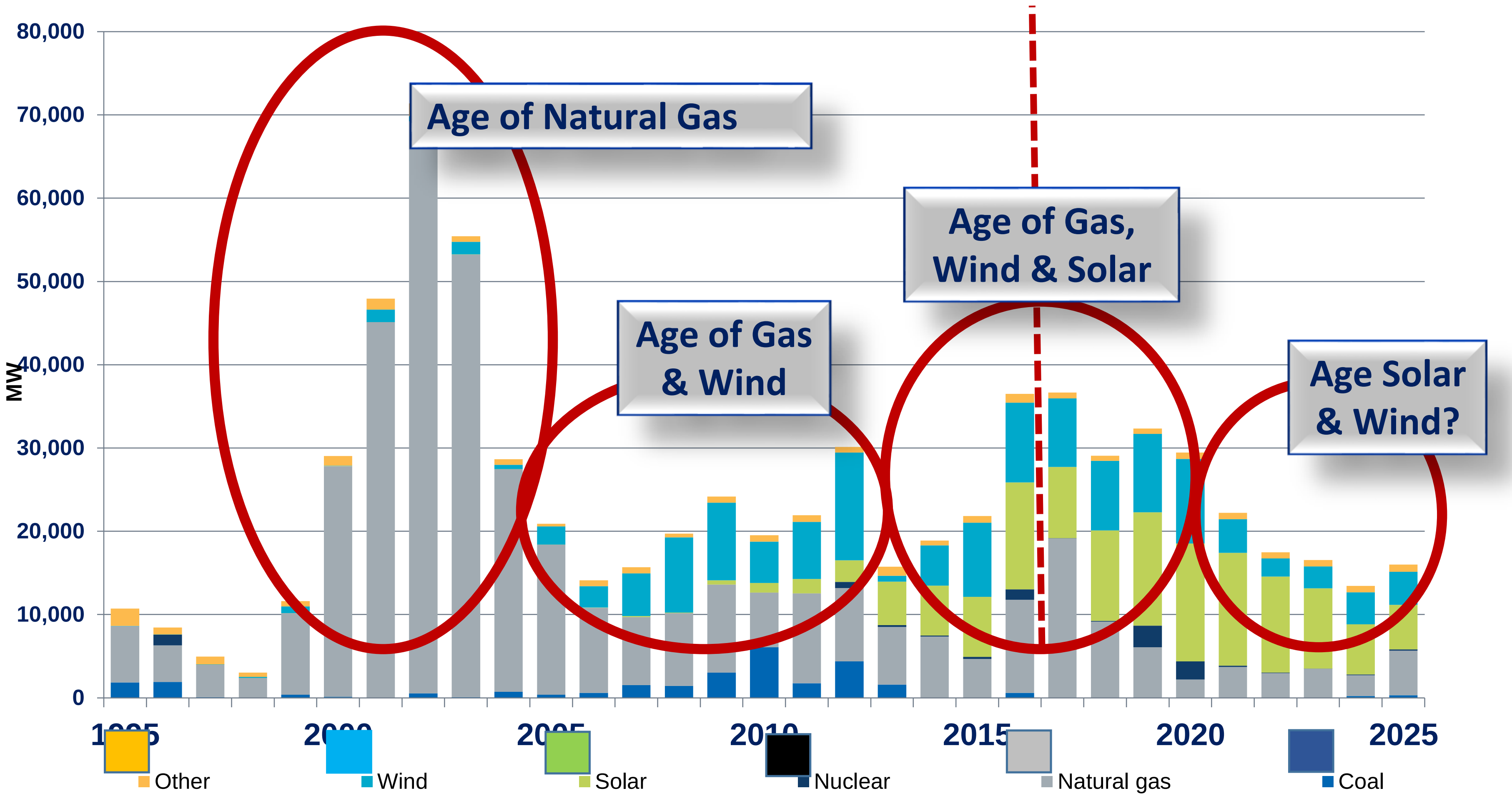
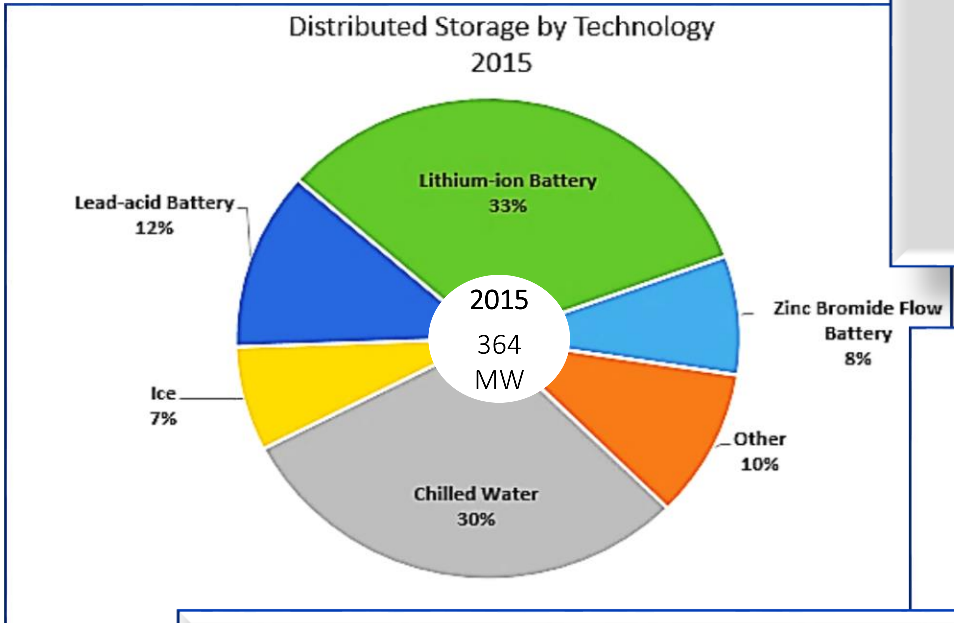
Source: IHS North American Power Market Outlook | June 2016

Capacity Additions, 1995-2025

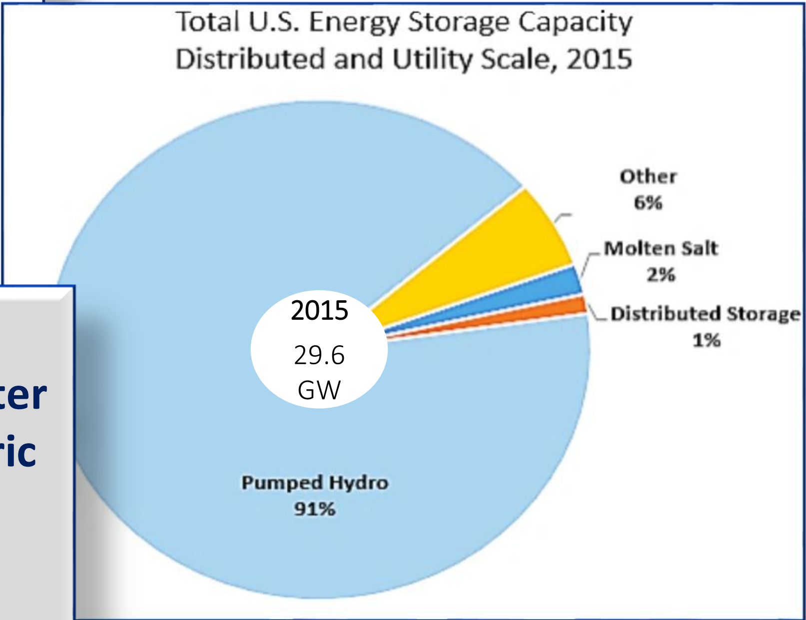


Notes: Additions exclude coal-to–natural gas or biomass conversions.
Source: IHS and ABB Velocity Suite

Distributed Energy Storage



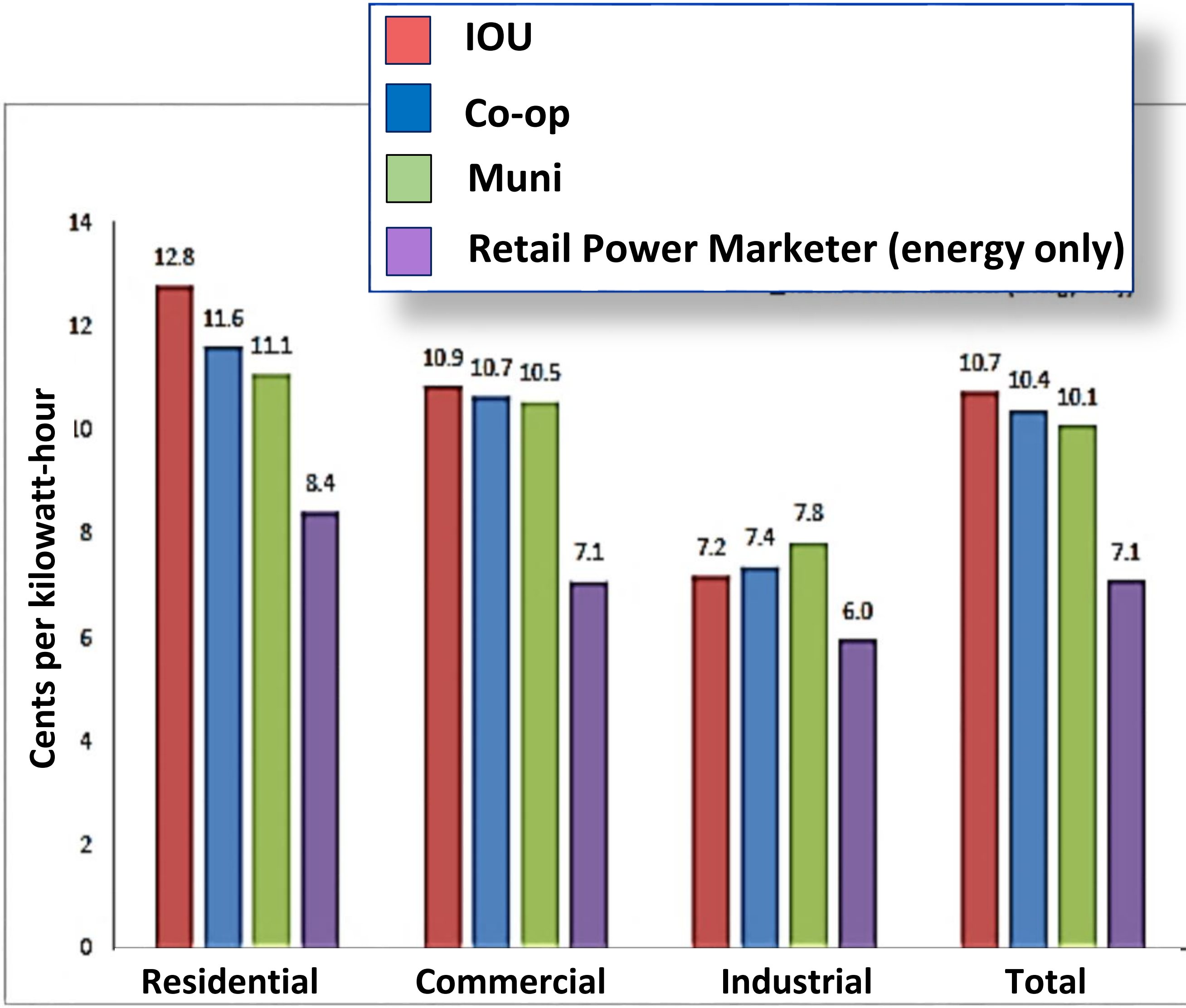
- **From an end-use perspective, distributed electricity storage can reduce peak load and facilitate adoption of distributed generation**



- **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.**

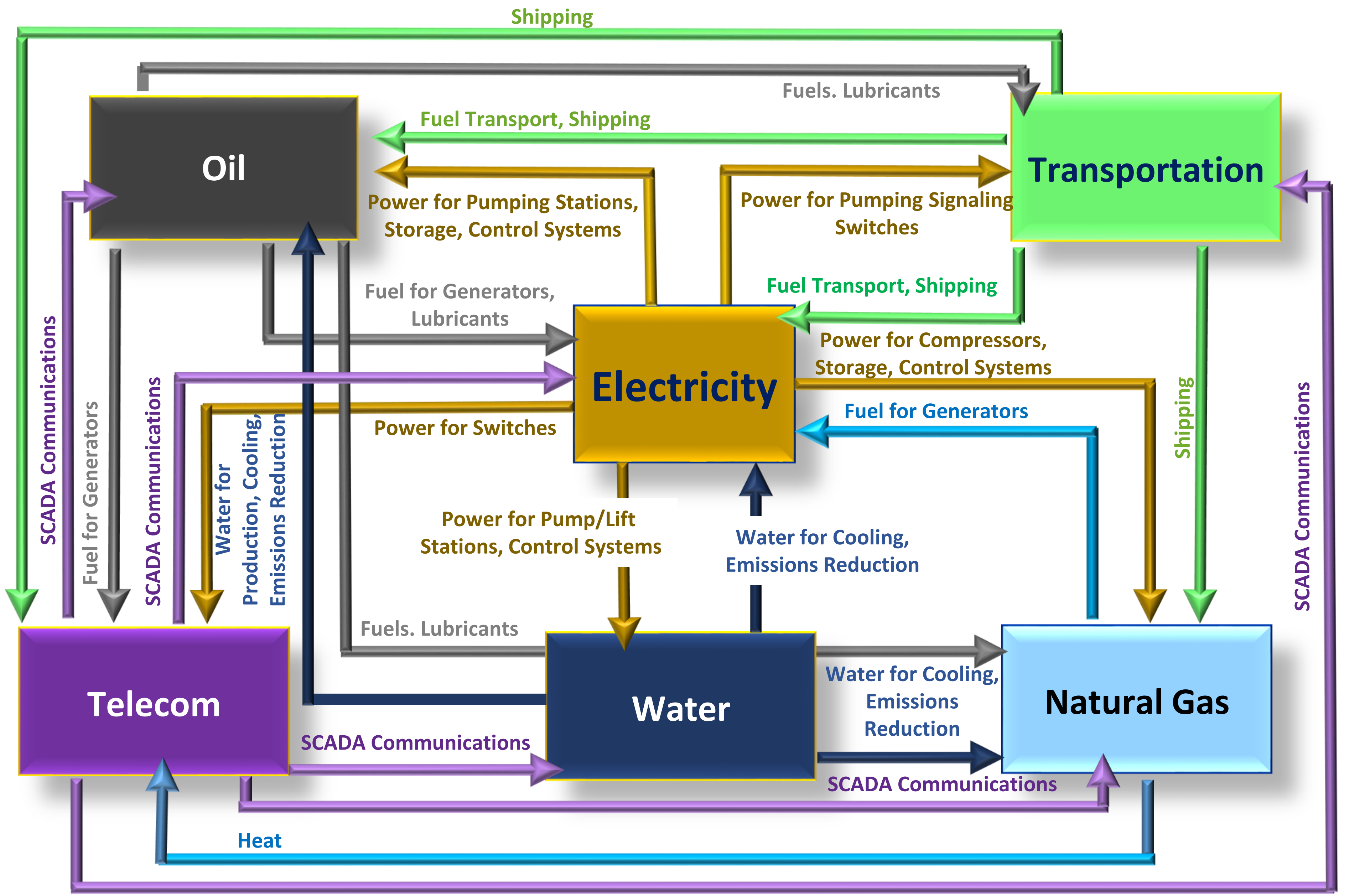
Source: DOE Global Energy & Storage Database. Accessed September 2015.

Rates Vary by Class and Utility Type



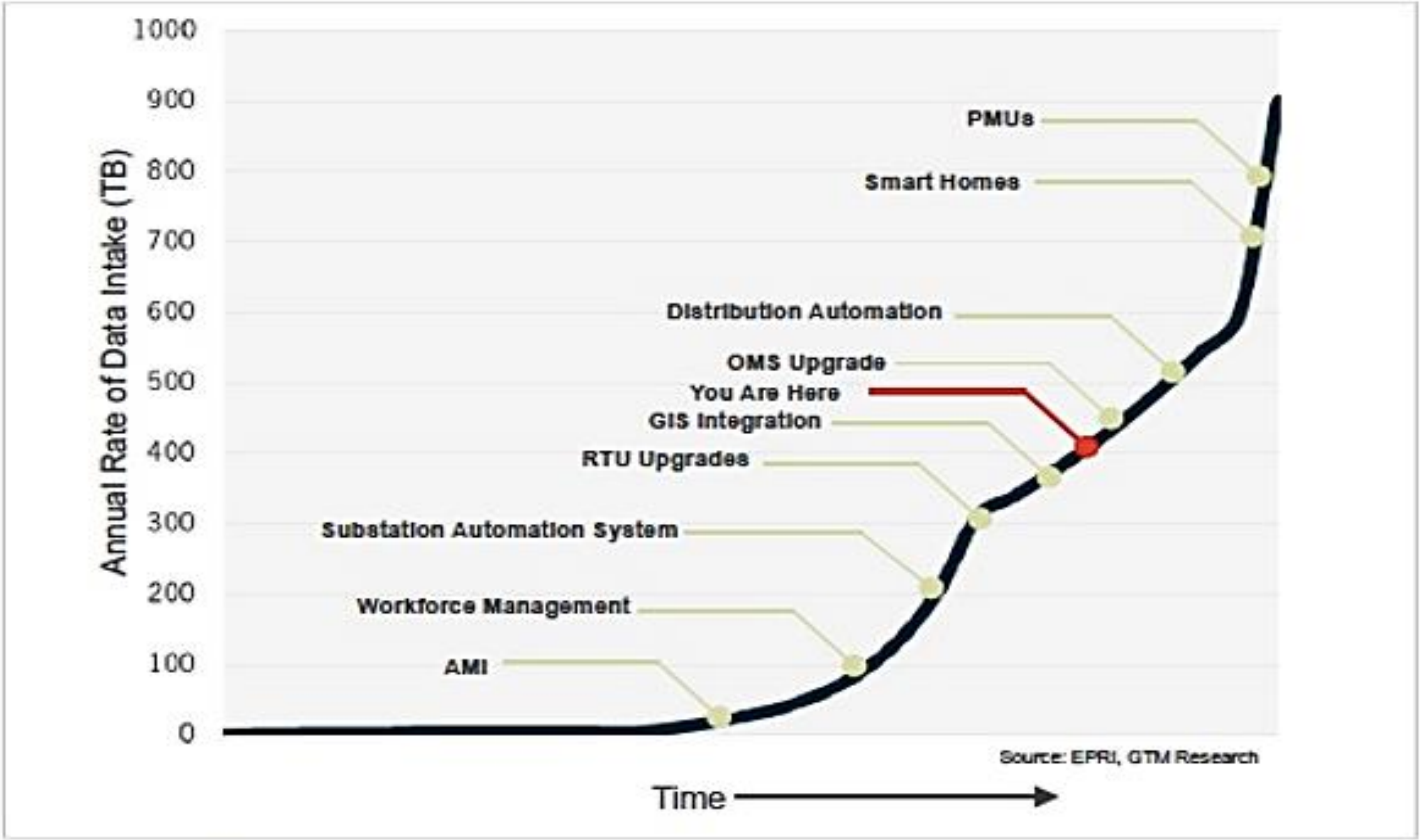
- Generation is by far the largest component of retail rates.
- Industrial customers typically pay the lowest rates, partially determined by cost differentials, but also by policy goals such as economic development or income-rate progressivity.
- Rates for public utilities are slightly lower than those 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



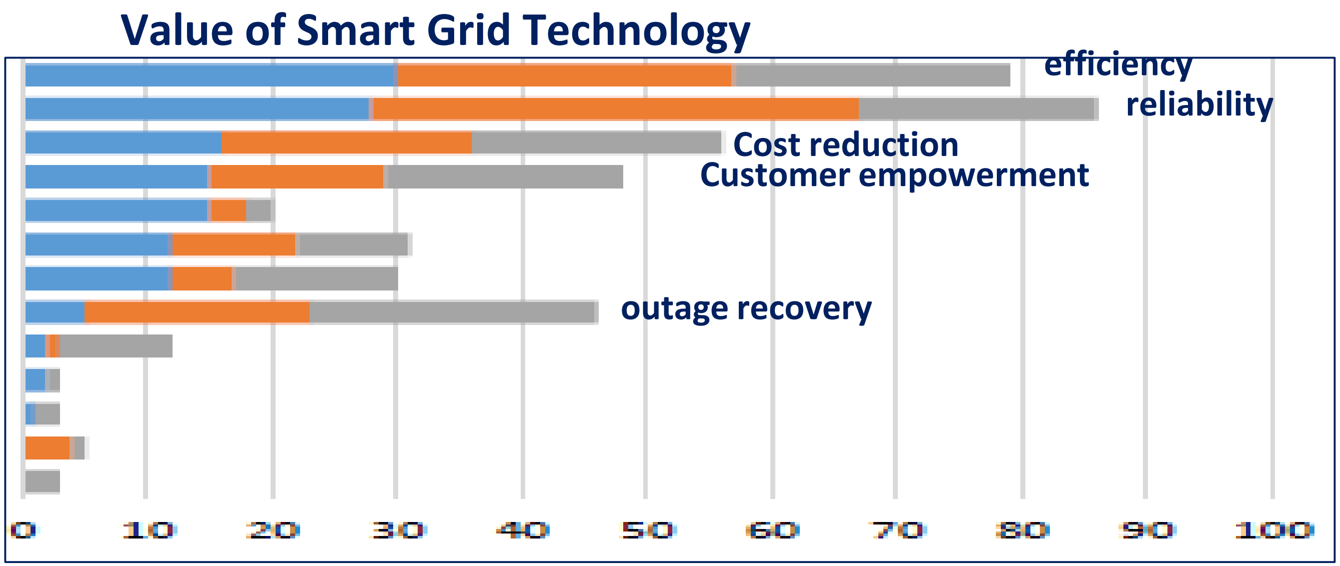
Growing Digitization

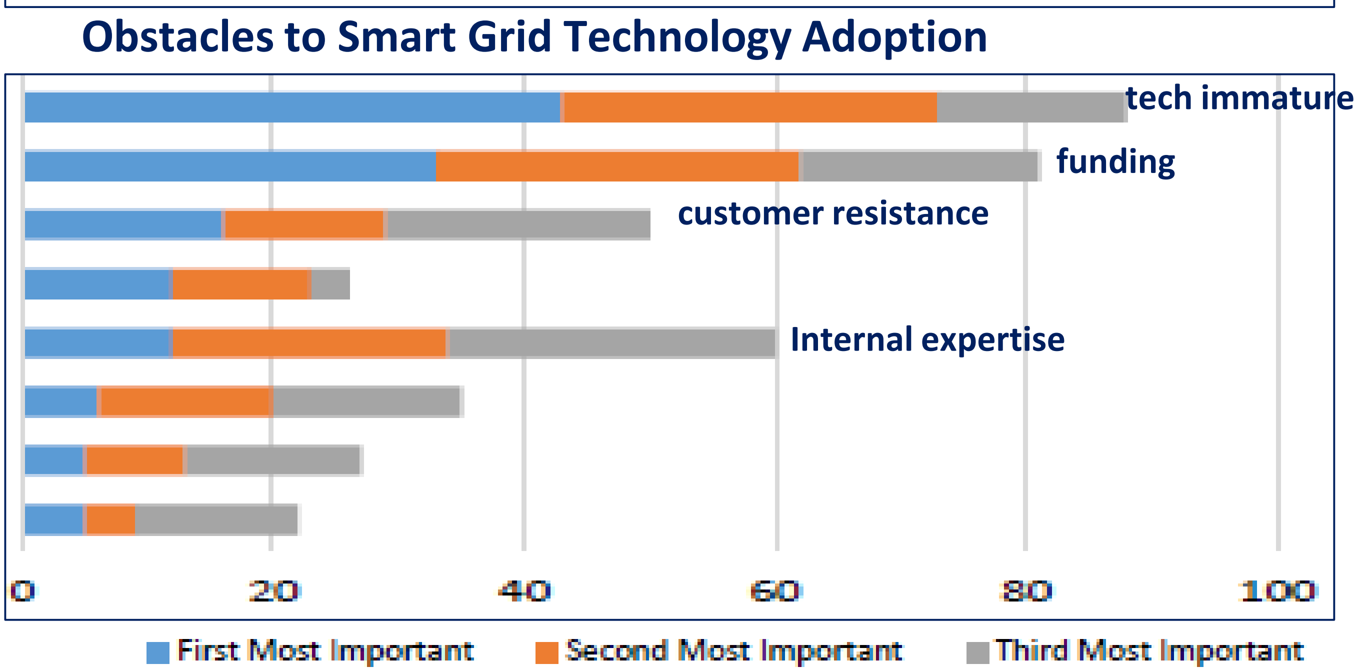
Figure 6: The Growth of Data in the Power Industry[29]



SOURCE: GTM RESEARCH

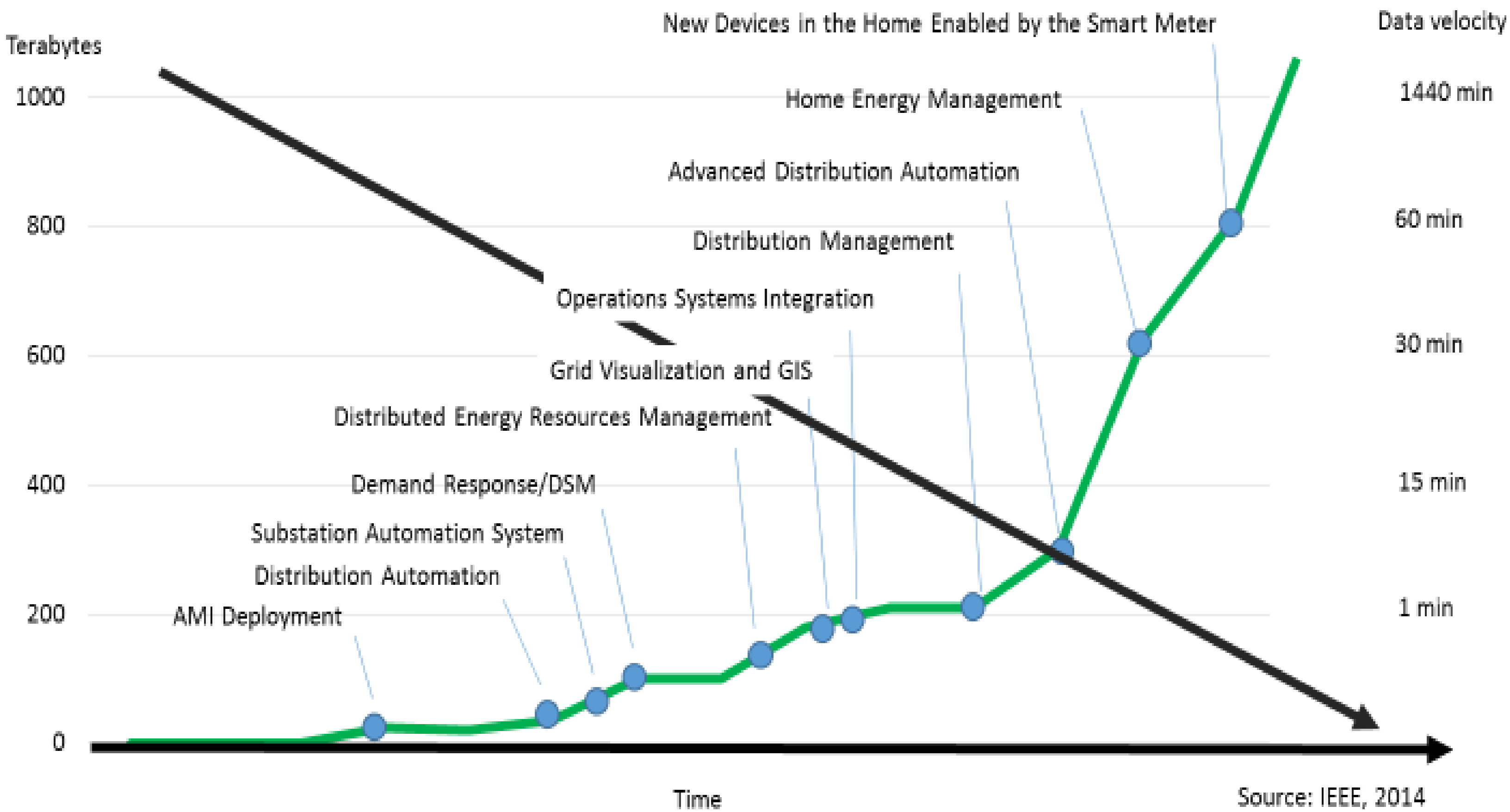
50 Million Installed Smart Meters





Speed of Information

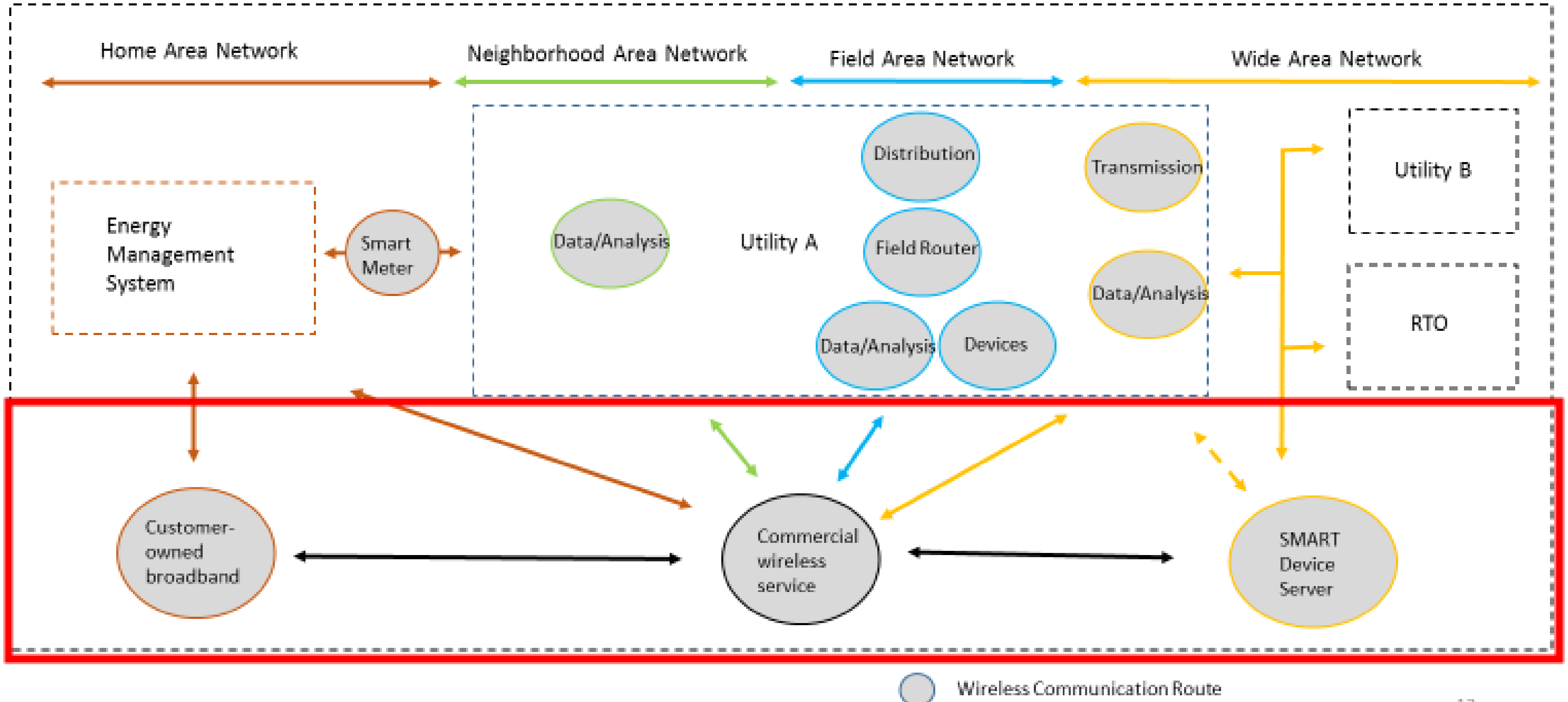
Smart grid will rely on processing exponentially more data at exponentially faster speeds



Source: IEEE, 2014

Internet of Things

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

QUADRENNIAL ENERGY REVIEW

QER 1.1 and1.2 Update for NASEO

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September 12, 2016 | Washington, DC