Disruptive Innovation

How DERs are Impacting the US Electric Sector

February 28, 2017

United States Energy Association (USEA)

Steven Fine
&
Philip Mihlmester

Agenda

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- **DER Overview: Key Technologies and Trends**
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  - Energy Storage
- **Key DER Impacts**
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  - Distribution Planning
  - Distribution System Operations
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  - Regulatory Construct
  - Wholesale Market
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ICF: WE MAKE BIG THINGS POSSIBLE

Energy

Health

5,000
EMPLOYEES

Environment

Transportation

1 BILLION+
IN REVENUES

Global presence with more than 65 offices headquartered in the Washington, DC area

AMERICA'S BEST MANAGEMENT CONSULTING FIRMS 2016
– Forbes

Distributed Energy Practice: What We Do

From the necessary analytics to help shape strategy/business plans and regulatory filings, to the design and implementation of integrated DER programs grounded on state-of-the-art customer engagement, we can help capture value in each stage of the evolution.

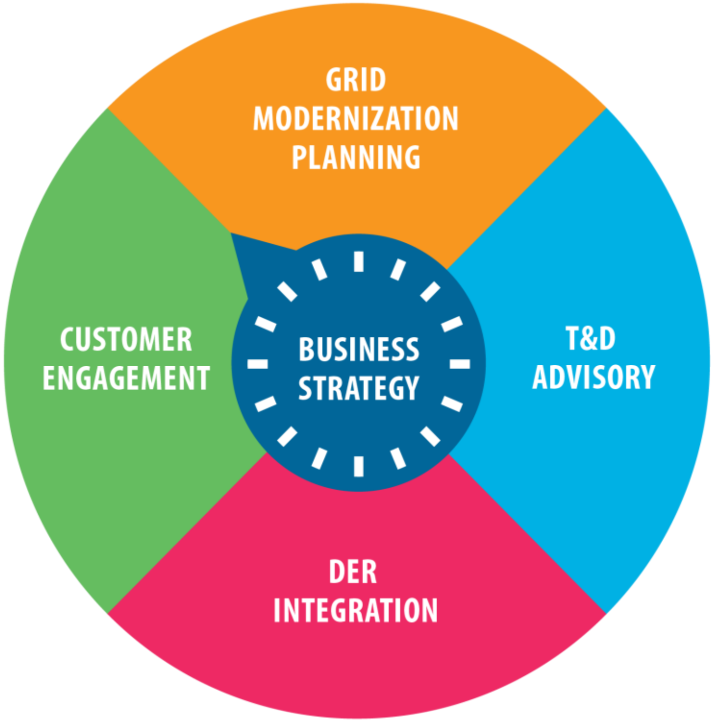
- **Multisector and Multidisciplinary**
  - Our depth and breadth fosters innovative, comprehensive, and integrated solutions for our clients
- **Leading Edge Analytics**
  - Foundational modeling and analytical capabilities that inform strategic decisions on customer engagement, generation and grid investments and DER valuation and sourcing
- **Delivery of over 150 DSM Programs**
  - Expertise in the design, optimization and delivery of residential and C&I programs for 45 U.S. utilities
- **Comprehensive Experience for Complex "Utility 2.0" Issues**
  - Insights from leading utility engagements in NY, CA, MN, AZ, MA, HI, Canada & Australia

Our core distributed grid offerings

ICF helps utilities navigate industry change, with an emphasis on the transition to a more distributed grid

Example questions we can help answer:

- How will distribution planning need to evolve to ensure safety and reliability in a system with more DER?
- How can DER be leveraged to meet system needs and lower costs?
- What technology investments are needed to enable new planning and operations functions?
- What are practical near-term steps to prepare the grid for the future?
- How can DER be integrated into customer programs to enhance customer satisfaction and increase utility benefits?



DER Overview: Key Technologies & Trends

DER Overview

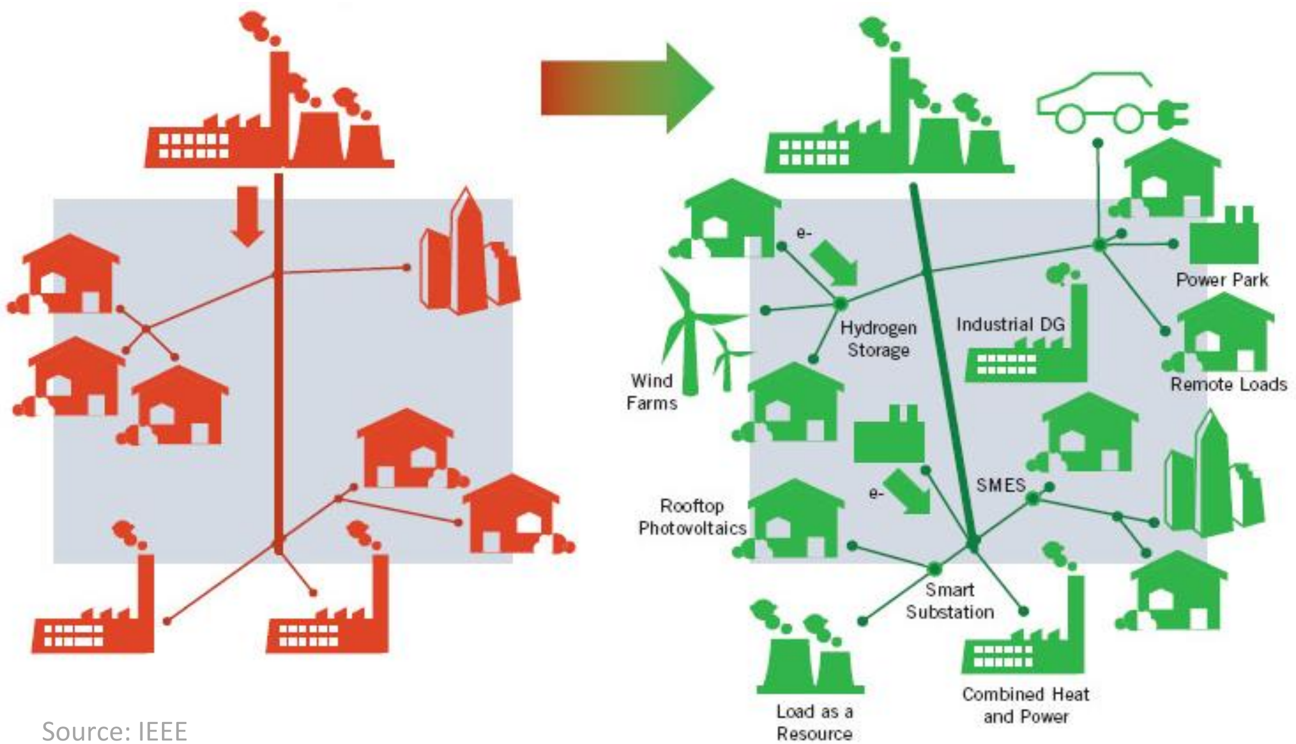
- **Distributed Energy Resources (DERs) includes:**
  - Distributed Solar
  - Energy Storage
  - Energy Efficiency
  - Demand Response
  - Combined Heat and Power (CHP)
  - Electric Vehicles

Managed Load

- **The value proposition for DER is strengthening due to:**
  - Declining costs
  - Improved operational performance
  - More favorable incentives/policies
  - Growing consumer demand
  - Enhanced ability to provide grid services

The Evolution of the Grid

ONE-WAY ROAD TO MULTI-DIRECTIONAL NETWORK



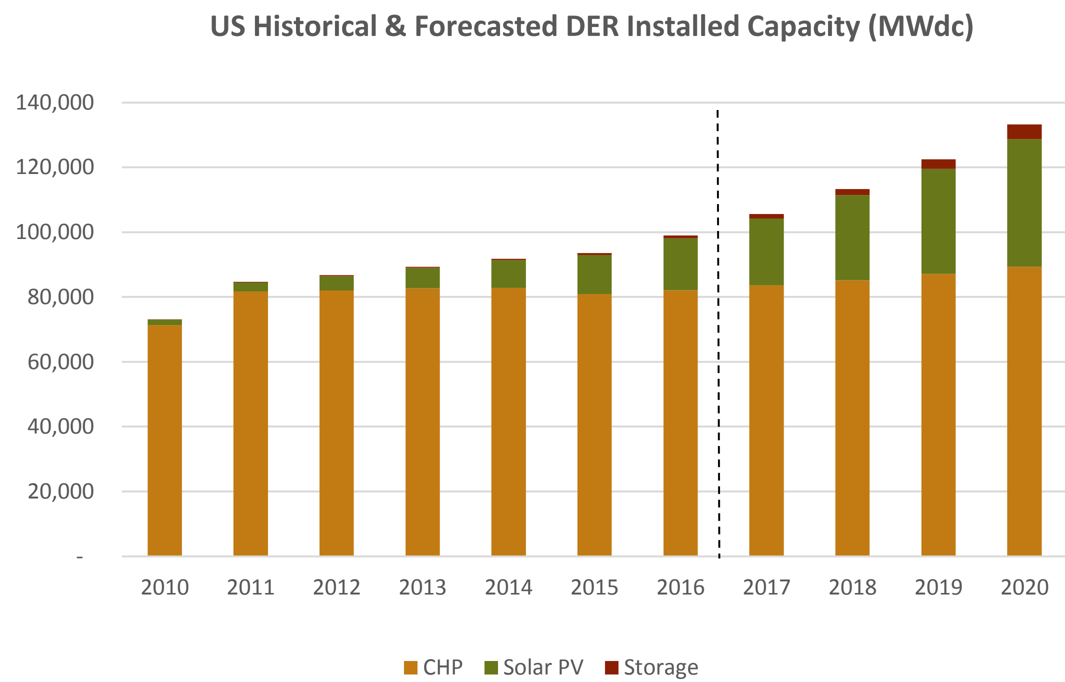
Source: IEEE

Utility roles and models are changing – a more distributed future presents new challenges ***and opportunities***

DER Technologies Gaining Traction

- Relatively small absolute MW numbers, but growing. MWh remain relatively low
- From an installed base of ~12GW nationally, solar DG is expected to grow to 39 GW in 2020. Current leading states are CA, NJ, MA, AZ, NY
- Cumulative BTM storage expected to reach 2 GW by 2021

Cum. GW	2016	2020
Solar PV	12	39
Storage	0.16	2
CHP	82	89



Sources	Solar PV	Storage	CHP
Historical	GTM	DOE, GTM, BNEF, EIA, ESA	ICF
Forecast	ICF	GTM	ICF

BTM Solar PV: Key Drivers

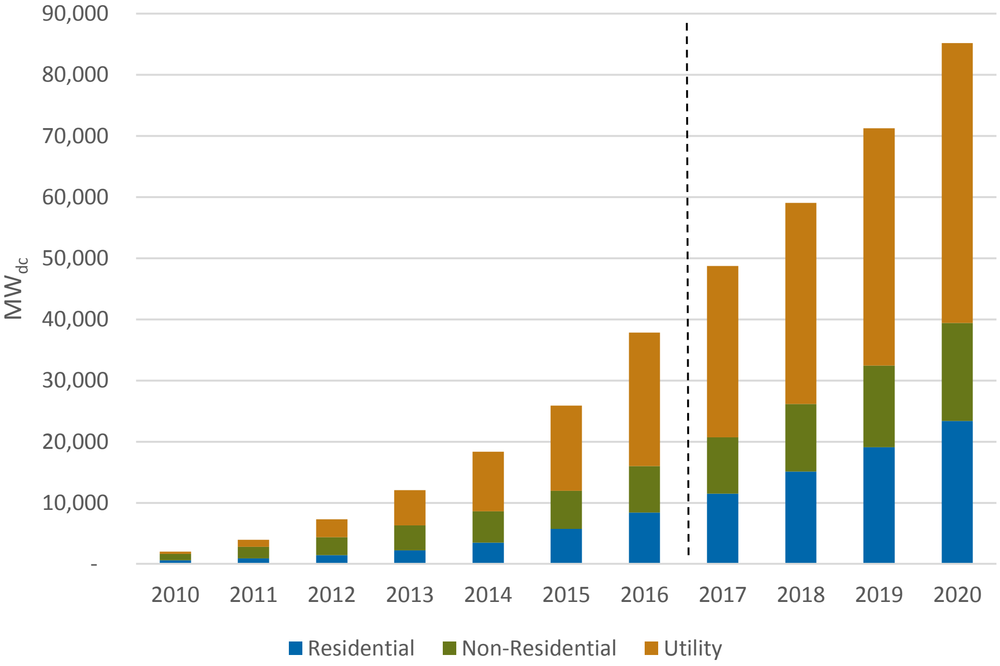
- **Net Metering**
  - Currently, 41 states + DC + 4 US territories have NEM in place
  - In 2016, 15 states + DC proposed or undertook studies on NEM successor tariffs i.e. VOS and Value of DER frameworks
- **Environmental**
  - RECs, SRECs, RPS and Solar Carve-Outs
  - Corporate sustainability
- **Utility ownership of rooftop PV programs**
- **Community solar pilots/programs**
  - Cumulative 106 MW installed by Q1-2016
  - 14 states + DC have shared renewable policies in place or under consideration
- **Financing and Ownership Models**
  - Growing number of new loan providers entering market
    - Customer-owned systems increased from 38% in 2014 to 45% 2016
  - Federal ITC extension, MACRS
  - Third-party financing (i.e. leases, PPAs)
    - Declining, but expect to become more important again after the residential ITC expires in 2023

National Avg. Installed Costs (2016)		
Type	**Installed Cost**	**System Size**
Residential	$16,000	5 kW
Commercial	$945,000	500 kW

Solar PV Market: Capacity by Sector

With the extension of the Federal Investment Tax Credit for (ITC), and continued cost declines, solar growth is projected to more than double from 2016-2020

US Historical & Forecasted Solar PV Installed Capacity (MWdc)



Source: Historical GTM, Forecasted ICF

Behind-the-meter (BTM) = Residential + Non-residential
Non-residential = Commercial + Community

Installed Base in GW_{dc} (Q2 – 2016)	
Type	**Installed Capacity**
Utility	16.1 GW
Residential	7 GW
Non-Residential	6.8 GW

Assumptions:

- **California** will keep **retail-rate NEM** at least at until 2020. System-size caps will increase non-residential over 1 MW but stay under 5MW to avoid high interconnection costs.
- **New York** on track to keep NEM at full retail-rate until 2020 as well, community installation will increase
- **Massachusetts** extended NEM caps by 3%, residential segment exempt from 40% NEM reduction. Pending SREC II incentive design post 2017.
- **Maryland** new community size up to 2MW with ownership up to 60% capacity

Energy Storage: Key Drivers

- **Market Drivers**
  - American Recovery and Reinvestment Act (**ARRA**) funded 16 projects ~538 MW ~ $185 million
  - C&I cost could fall by half to $200/kWh by 2020 and $160/kWh by 2025
  - Frequency regulation in select markets
  - Upgrade deferral
  - State incentives/rebates

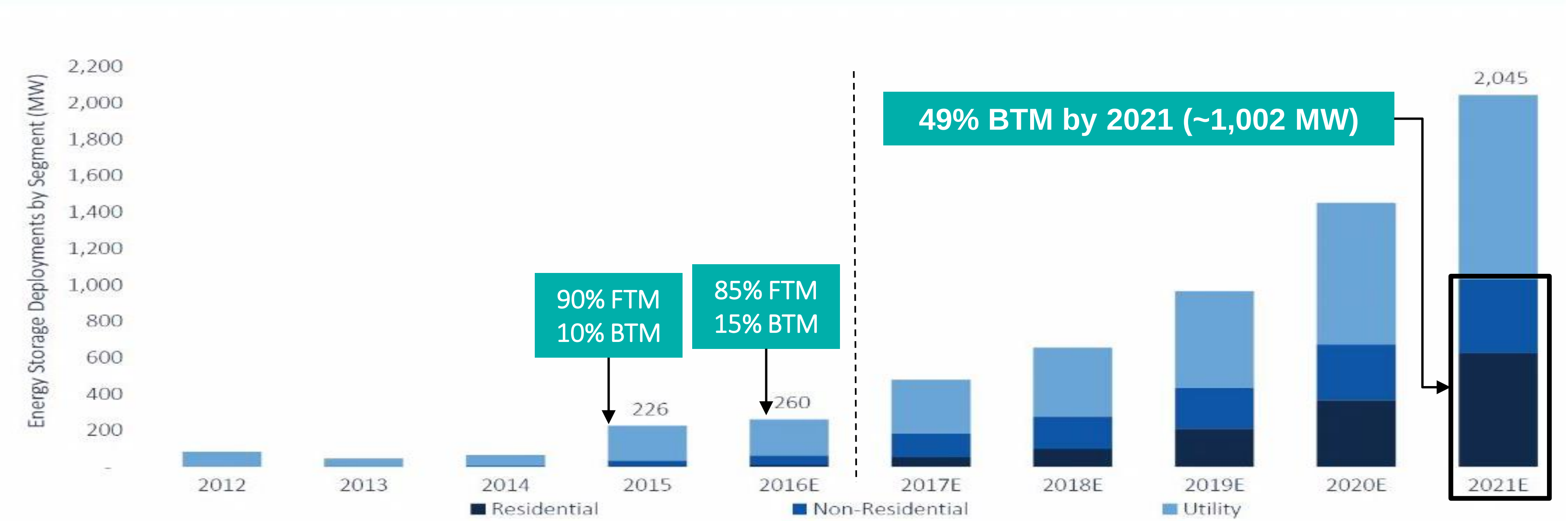
National Avg. Installed Costs (2016)		
Type	**Installed Cost**	**System Size**
Residential (Li-Ion)	$1,080/kWh - $1,955/kWh	5 kW
Commercial (Li-Ion)	$444/kWh - $1,321/kWh	1 MW

- **Regulatory Trends**
- **California**
  - NEM credit estimation monthly methodology for small storage systems (<10kW) paired with NEM-eligible generation, incentivizing customer to discharge when more valuable to the grid
  - CPUC directed procurement mandate for the IOUs - 1,325 MW by 2020 (bulk and distribution level)
  - Alison Canyon Gas Leak – Storage was a preferred resource to be procured for grid reliability
- **Massachusetts**
  - Potential 600 MW of storage procurement targets for electric utilities by 2020
- **Federal**
  - FERC issued a Notice of Proposed Rulemaking (NOPR) requiring ISOs/RTOs to remove entry barriers for energy storage participation in wholesale markets
  - Policy guidance issued in January 2017, allowing storage to recover revenues through market mechanisms and cost of service rates simultaneously

Energy Storage: Capacity by Sector

Capacity Additions and Projections		
Year	**FTM**	**BTM**
2016	221 MW	39 MW
2020	1,043 MW	1,002 MW

Storage economics are still challenging but quickly becoming competitive on the wholesale system. Value on the distribution system will be determined by falling costs and creating a value stack across revenue streams.



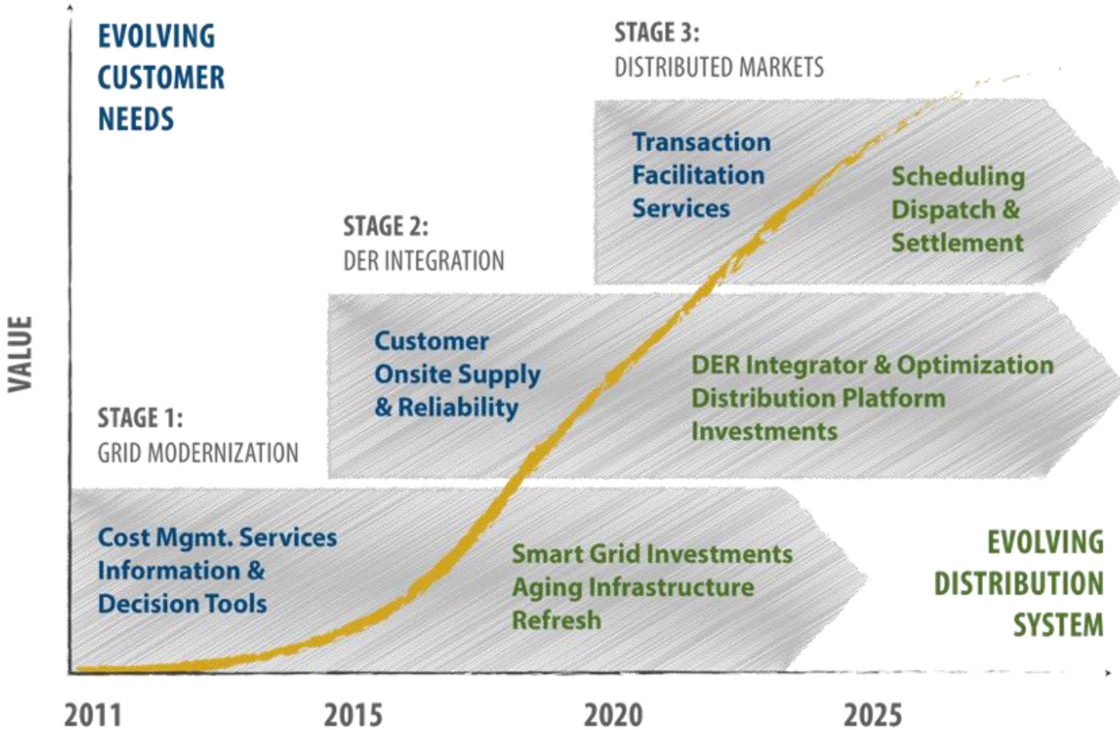
Source: GTM Research (only non-hydro sources)

This graphic reflects <u>only</u> new installations in each year

Key DER Impacts

Stages of Distributed Market Evolution

- **Utilities are currently in various stages of modernizing the grid, enhancing planning practices and testing new market mechanisms**
- **These fundamental investments and actions will facilitate DER integration and future distribution-level markets**
- **These efforts are occurring across all aspects of the utility's business:**
  - Grid Operations
  - Distribution System Planning
  - Market Operations
  - Regulatory

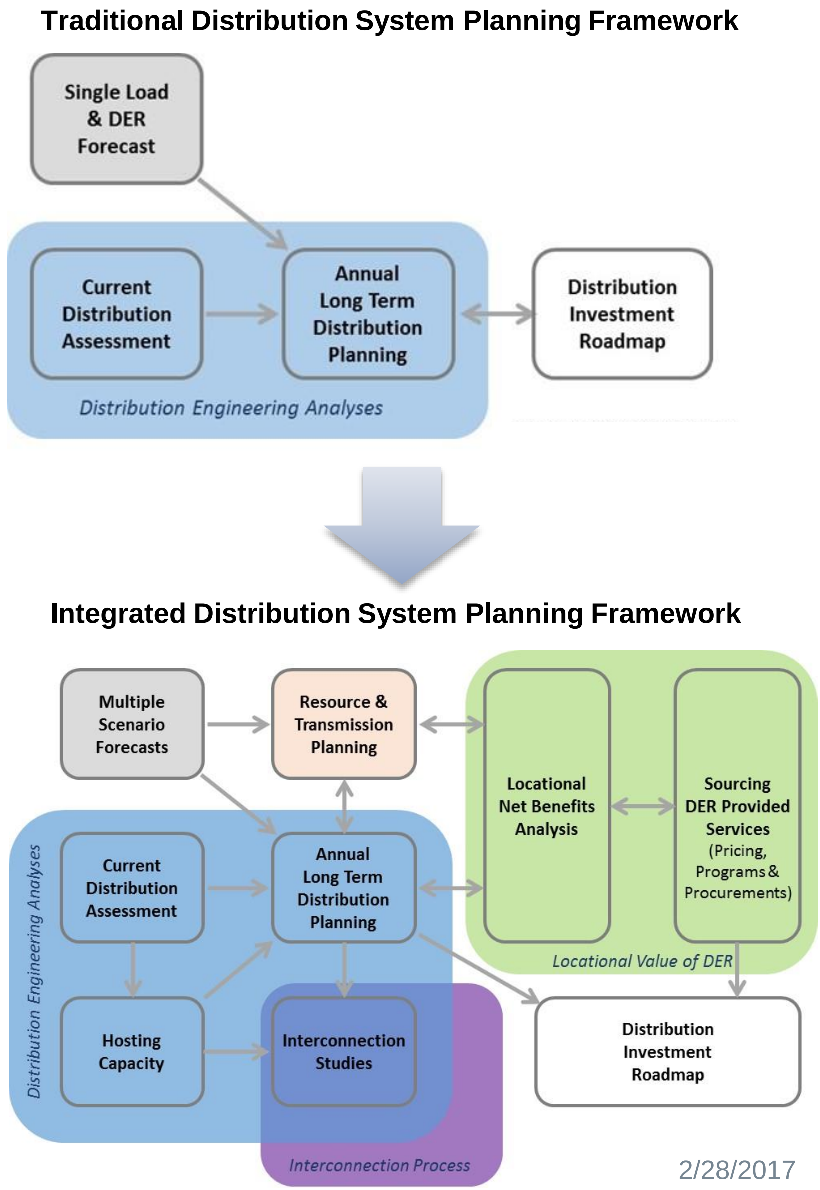


Source: Paul De Martini, ICF

Distribution Planning: Evolving to ensure safety and reliability in a system with more DER

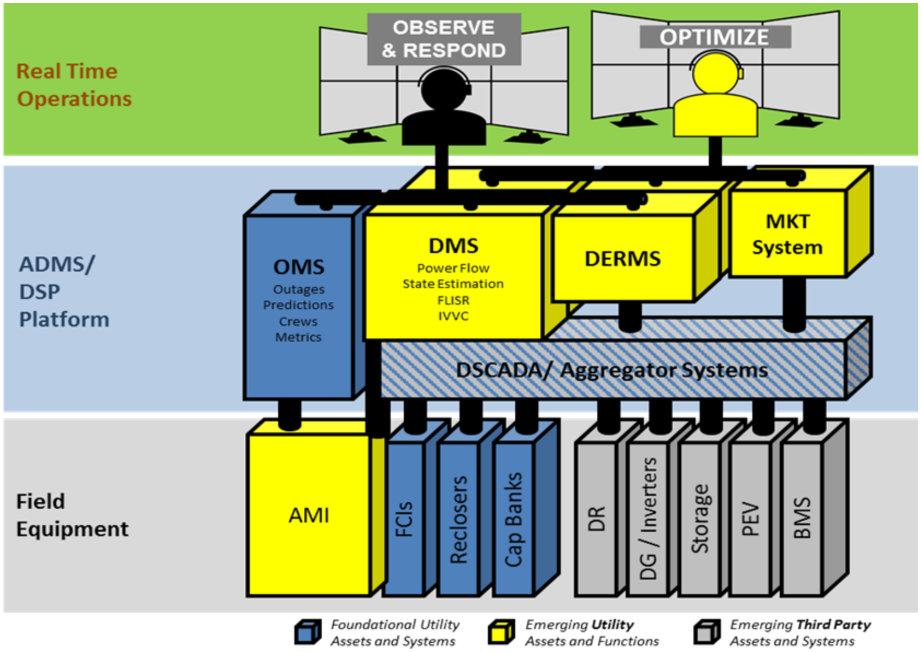
Regulators are increasingly asking utilities to incorporate DER into their distribution planning processes:

- Multiple DER & Load Growth Scenarios
- Hosting Capacity for Planning & Interconnection
- Resource & Transmission Planning Alignment
- Identification of Distribution Grid Needs
- Locational Value of DER
- Distribution Grid Services



DER & System Operations: Need for Visibility & Agility

- **Change in the role of the utility from an observer of the distribution grid to an optimizer of assets on the distribution grid**
- **DERs inject energy into the system which requires utilities to enhance monitoring and control capabilities, automated decision making for optimizing DERs**
- **Operational control of DERs is becoming a major driver for grid modernization investments**

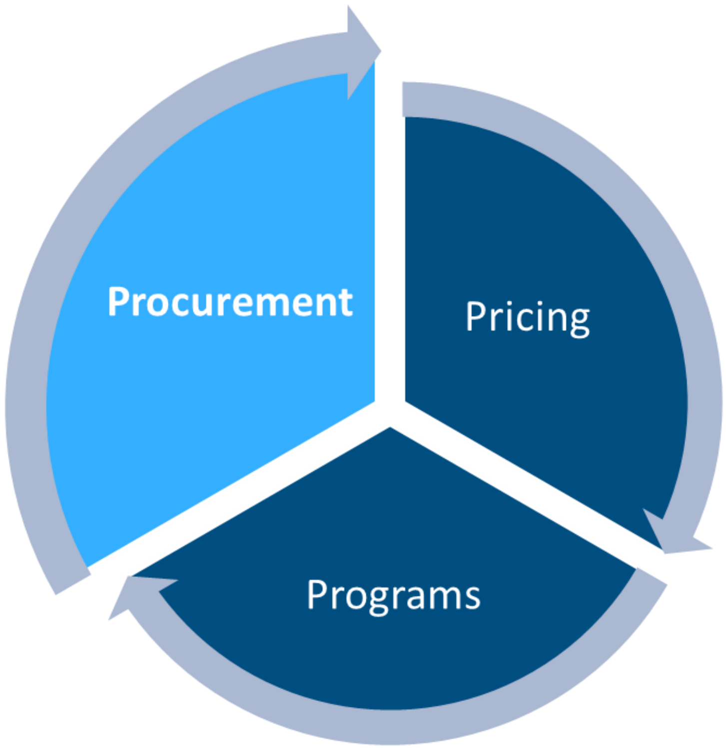


Source: Joint Utilities of New York, Supplemental DSIP, November 2016

DER & Distribution System Investments: The "Three Ps" of DER Sourcing

- **Utilities today mostly use Pricing and Programmatic methods to secure energy and capacity from certain DERs**
  - Pricing: NEM tariffs for energy exports from distributed generation
  - Programs: utility-sponsored EE programs

- **In the future, utilities will secure grid services from many DER types using a flexible combination of Pricing, Programmatic <u>and</u> Procurement approaches**

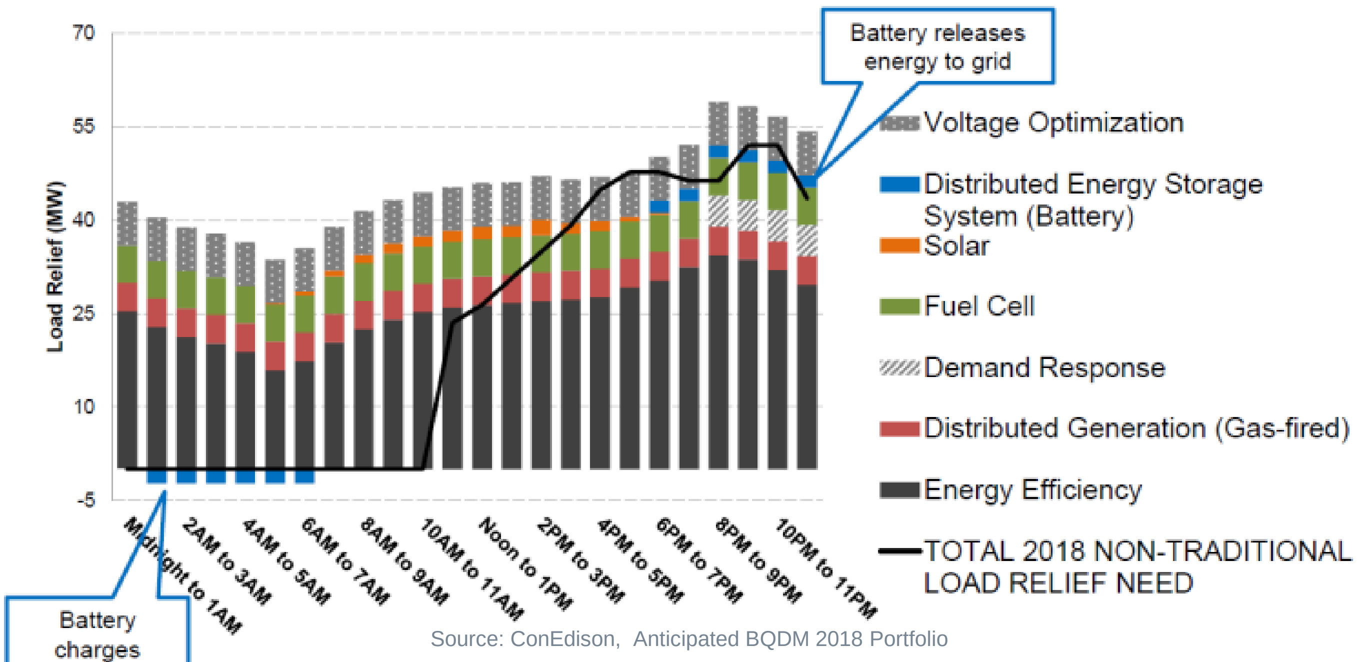


The Three P's of DER Sourcing

DER & Distribution System Investments: NWA Procurement

- **Utilities are beginning to procure DER as Non-Wires Alternatives (NWA) in order to defer or avoid traditional CapEx ("wires") investment**
  - Examples: Con Edison BQDM, SCE Preferred Resources Pilot auctions, National Grid, Eversource

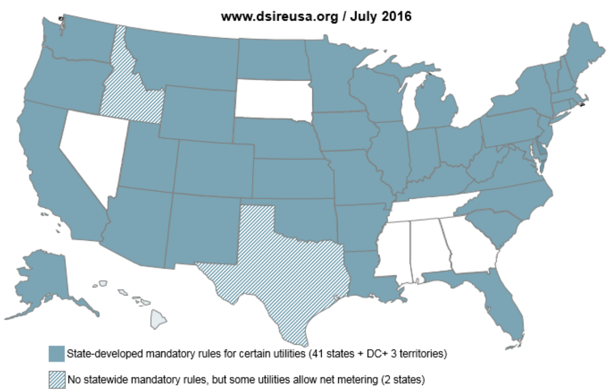
- **Evolving locational value methodologies will influence how DER is valued in the procurement process**



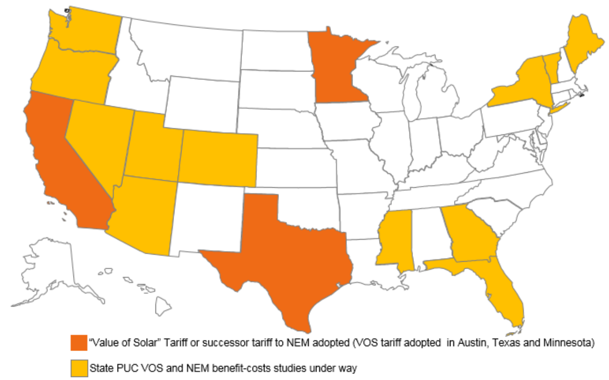
Source: ConEdison, Anticipated BQDM 2018 Portfolio

DER & Regulatory Construct: Value of DER

- **Value of DER has evolved across various states from original Net Metering (NEM) rate designs to Value of Solar (VOS) and now to Distribution Resource Planning (DRP)- based value**



Net Energy Metering (NEM)



Value of Solar (VOS)

Distribution Resource Planning

- **The focus is to clearly identify and assign a net value (positive or negative) of DER into ratemaking and rate designs**

DER & Regulatory Construct: A Closer Look at the Evaluation Frameworks

Locational Value Components Included in the Assessment Frameworks of CA, NY and MN

Avoided Costs
Avoided T&D
Sub-Transmission / Substation / Feeder
Distribution Voltage / Power Quality
Distribution Reliability / Resiliency
Transmission
Other Avoided Costs
Avoided Generation Capacity
Avoided Energy
Avoided GHG
Avoided RPS
Avoided Ancillary Services
Other
Renewable Integration Costs
Societal avoided costs
Public safety costs

LNBA Methodology Framework Approved by CPUC for California IOUs Demo B (2016)

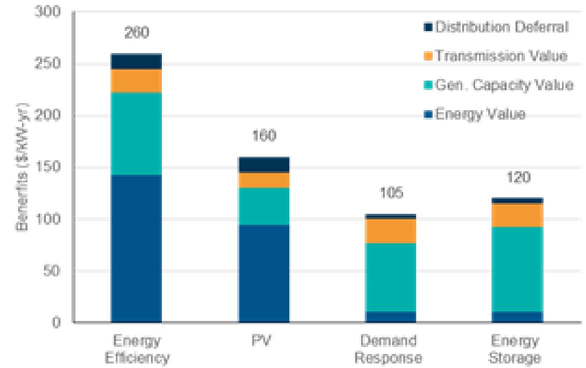
BENEFITS
Bulk System
Avoided Generation Capacity (ICAP), including Reserve Margin
Avoided Energy (LBMP)
Avoided Transmission Capacity Infrastructure and related O&M
Avoided Transmission Losses
Avoided Ancillary Services (e.g. operating reserves, regulation, etc.)
Wholesale Market Price Impacts
Distribution System
Avoided Distribution Capacity Infrastructure
Avoided O&M
Avoided Distribution Losses
Reliability / Resiliency
Net Avoided Restoration Costs
Net Avoided Outage Costs
External
Details omitted for brevity
COSTS
Details omitted for brevity

New York Benefit Cost Analysis Framework

Avoided Costs
Avoided Fuel Cost
Avoided Plant O&M - Fixed
Avoided Plant O&M - Variable
Avoided Gen Capacity Cost
Avoided Reserve Capacity Cost
Avoided Trans. Capacity Cost
Avoided Dist. Capacity Cost
Avoided Environmental Cost
Avoided Voltage Control Cost
Other
Solar Integration Cost

Minnesota Value of Solar Calculation Framework, developed by CPR 2014

DER & Regulatory Construct: Value of DER



DER Potential

DER Characteristics

Bulk Power System Impacts

Distribution Deferral Benefit

Cost of Traditional Grid Upgrades

DER Benefits

Locational Value

EE/DER Optimization and Portfolio Design

ICF's new analytical approach demonstrates and optimizes the value of EE and DER programs on a locational basis, and unlocks pockets of value currently overlooked

DER & Regulatory Construct: Utility Business Models

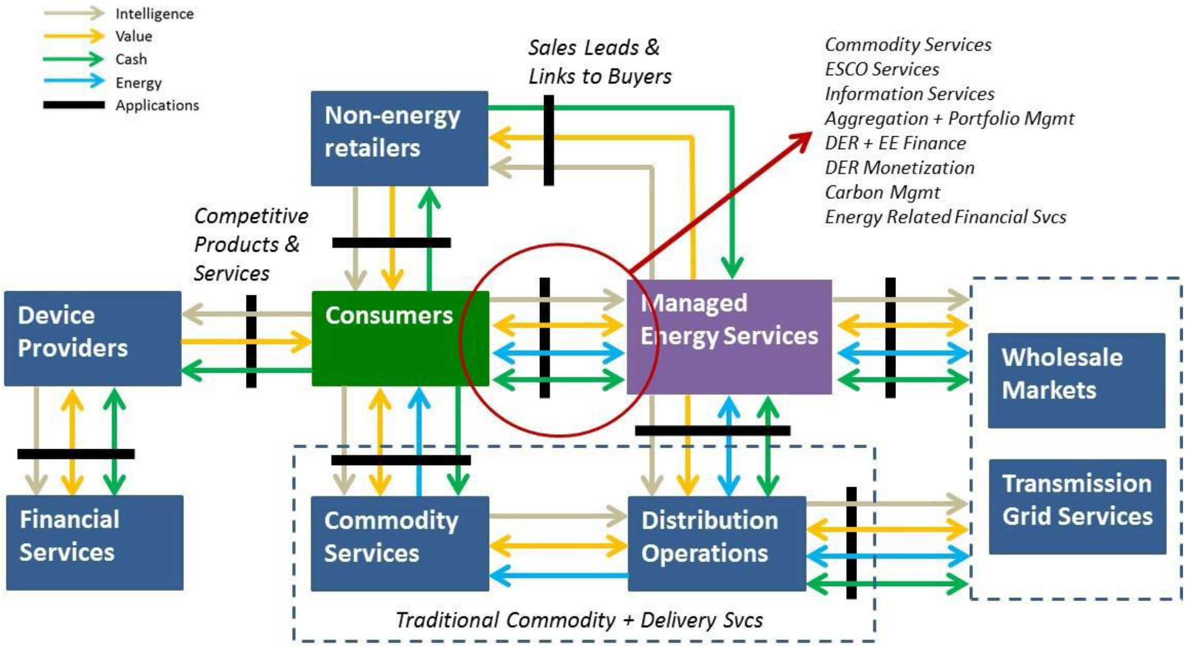
- **Utilities are already getting pressure to evolve from traditional Cost of Service (COS) commodity providers to value-driven curators of the customer's experience**
- **A high-DER future will likely bring new opportunities to earn platform revenues – but to what extent will utilities be allowed to participate?**
  - Establishment of a Distribution System Operator (analogous to ISOs at the wholesale level) to operate distribution-level markets and interface w/utilities
  - NY REV: vision is for utilities to evolve into Distribution System Platform (DSP) providers and earn revenues by coordinating transactions from DER and other assets across the distribution grid
- **Regulators will have to balance utility vs. third-party provision of value-added information and services, in order to most effectively stimulate DER market growth**
  - Treatment of utility revenue from these value-added services will require new regulatory techniques

DER & Regulatory Construct: Utility Business Models

- **Regulators should consider how utility investments in grid modernization technologies can enable new future utility business models and distributed markets, not just DER integration**

- **The more DER is added to the system, the greater the opportunity for utilities to capture value across networks**

A high-DER future will provide opportunities for utilities and/or DSOs to earn platform revenues for DER optimization, information, settlement and other services



Source: Paul De Martini, Newport Consulting Group 2015, https://www.nga.org/files/live/sites/NGA/files/pdf/2015/1507LearningLab_DeMartini.pdf

DER & Market Design: Wholesale Market Impacts

- **DER participation in wholesale markets is still under development**
  - Demand
    - – Load Modifying DERs like BTM Solar and EE modulate load forecasts (short-term and long-term)
      - PJM, ISO-NE now integrate BTM solar in load forecasts
      - For Operational purposes, ISOs are increasingly looking at ways to anticipate BTM generation, to anticipate the impact of variability in BTM generation on the T-D interface
  - Supply
    - – Demand Response (DR) as a demand-side resource is a well-established ‘supply’ option during times of system stress
    - – DER in the form of aggregates may also be dispatched based on economics in the near future.
      - FERC NOPR directs ISOs/RTOs to develop participation models that allow DER aggregations to provide all possible services (energy, capacity and ancillary)

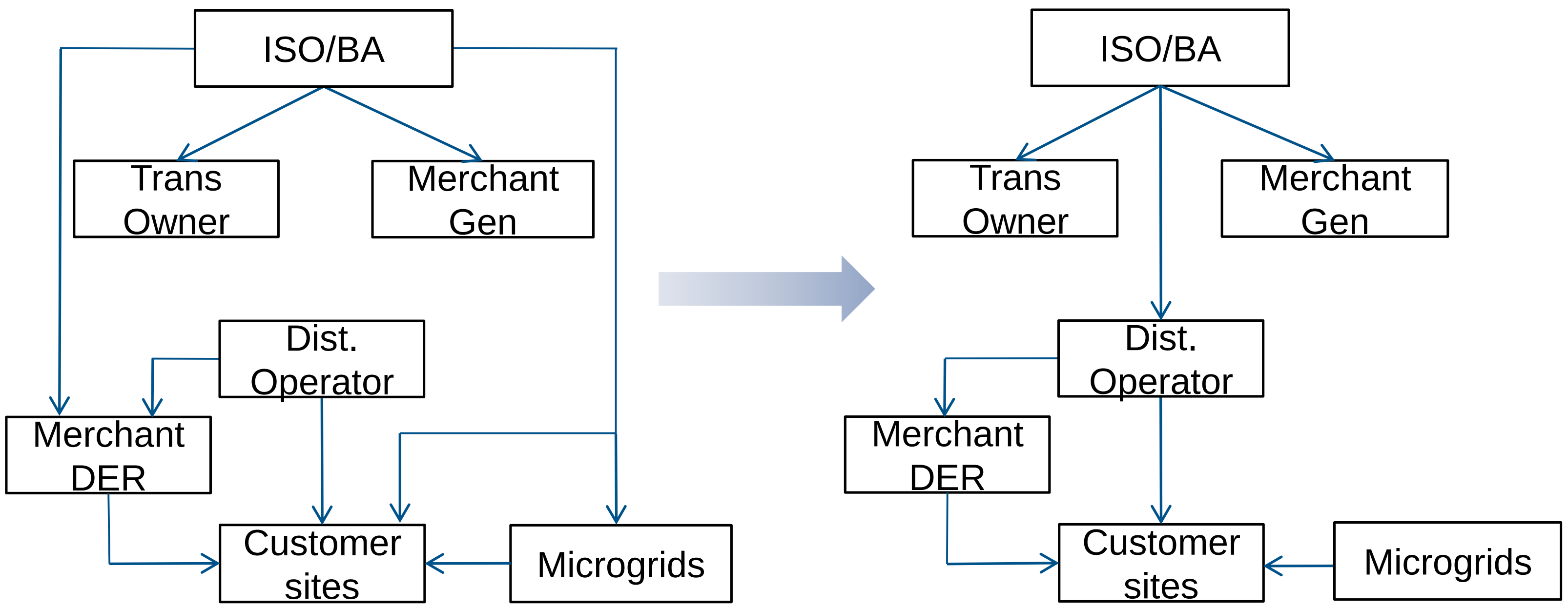
DER & Market Design: Wholesale Market Impacts

- **DER participation to be facilitated by Aggregators**

- **Increased DER penetration will require deliberation on operational and planning aspects between the ISO/RTO, Utility and the DER Aggregators**
  - What information is shared by the entities and how is it shared?
  - How is dispatch coordinated between the entities?
  - What operating procedures are needed to monitor and control the dispatch of DER in normal and emergency conditions (real time and contingent)?
  - How can short-term and long-term forecasting be streamlined to reflect appropriate levels for DER penetration and operations?

- **The outcomes of the deliberation hinges on the functional capabilities that distribution utilities adopt and invest in**
  - Advanced DSO vs. Minimal DSO

Coordinating ISO and DSO Roles and Functions



Source: Jeff Taft, PNNL

- **Grid architectural questions regarding how the ISO interacts with DERs and vice versa are being raised – but not answered yet**
- **Questions of interface between ISO, DSO and DER and who has visibility and control down to the grid edge**

The Road Ahead

Key Policy Issues

- **Reforming Business Models for the Electric Utility Sector**
  - Traditional regulatory compact may impede DER integration
  - How prices are set, how companies earn money, and how operational efficiency can be achieved?
- **Redesigning Electricity Markets**
  - How electricity markets can adapt and tap into the value provided by resources at grid-edge?
  - FERC NOPR is a step in right direction but it needs to be seen how ISO/RTO market design acknowledges DER limitations and capabilities
- **Revamping System Planning and Operations**
  - How long-term forecasting, resource planning, and day-to-day activities are conducted?

Key Policy Issues (contd.)

- **Renegotiating Jurisdictional Boundaries**
  - How jurisdictional boundaries are determined and how coordination between authorities is undertaken?

- **Ensuring Information Privacy and Determining Data Ownership**
  - How customer data is owned and protected and how information can be used?

Source: Energizing Policy Evolution for Grid Revolution, an ICF White Paper

Key Questions

Federal level

- FERC NOPR on participation of Energy Storage and aggregated DER in wholesale markets needs to provide further jurisdictional guidance
  - Rate treatment of energy used to charge a BTM storage providing wholesale market services
  - Dual participation of DERs for wholesale and retail programs
- NERC Critical Infrastructure Protection Standards
  - DERs primarily reside outside FERC and NERC jurisdiction, they will still need some oversight as they begin to provide critical grid services, particularly to the transmission system

State level

- Future of NEM?
  - NEM revisions in the context of retail rate reform and the need for higher fixed cost recovery in end-user rates could put a damper on DER compensation
- DER Integration Cost-Benefit Analysis
  - Need to net the Value of DER to the distribution grid against required accompanying grid modernization investments
- Can rate design keep up with a temporal- and location-specific Value of DER?

Key Takeaways - DERs & Impact on US Electric Sector

- **DERs are increasingly impacting the core fundamentals of the US electric sector - revenue streams, rate models, and business models.**

- **Maximizing DER benefits lies in unlocking their spatial and temporal value – getting locational, temporal and system values is important and evolving.**

- **Investments in Grid Modernization are needed to maximize possible benefits – figuring the use-case and how the system will evolve in complicated but necessary.**

- **The utility business model is evolving, driven by technological change and consumer preference. The vision is still evolving.**

Thank you

Steven Fine

steve.fine@icf.com

Philip Mihlmester

philip.mihlmester@icf.com