"REGULATORY REFORM TO ENABLE A NEW ADVANCED ENERGY ECO-SYSTEM"

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REGULATORY REFORM FOR AN ADVANCED ENERGY ECO-SYSTEM

- **"Game-Changing Drivers:"** Supporting New VER/DER Resources; Animating New Market Players; Fostering dissemination of smart technologies/data analytics to "digitalize" the Grid
- **Legacy Grid Operating System and Utility Business Model not designed to meet 21st Century Challenges and Opportunities or Assure Reliability and Power Quality**
- **New Technology and Resource Capabilities require New Grid Functionalities:** Forces of change placing new Demands on Grid, driving new Network Costs, prompting new Network Uses
- **Changing the Regulatory Paradigm: Reduce Barriers; Level the Playing Field; Capture Value of New Resources**
- **Shape New Parameters, Integrate New Players and Establish New Regulatory Structures** to assimilate change
- **Pathway: Interconnection to Integration to Intelligent Interconnectivity**

THE NEW CONSTANT: RAPIDLY CHANGING MARKET

- **"Sea Change in Electric Industry: Convergence of Technology, Policy and Customer/Market Forces of Change:**
  - Rigorous Renewable and Distributed Energy Policy Mandates, with new Desired Societal Outcomes, creating variability and proliferating points of power injection and withdrawal at grid edge, stressing traditional system capabilities; VER challenges in balancing Supply and Demand; Demand Flexibility
  - Technology Advancements and Deployment lowering costs, creating customer choices and opening opportunities for user to grid, user to user energy transactions and real time customer energy management; Clean Distributed Energy Resources (DER) as Solutions for Customers, Grid, Market and Communities; Pressure on Legacy Regulatory Compact to change;
  - Changing Market Conditions and Customer Needs and Expectations introducing new Market Players providing electricity-related products and services, increasing competition for end use service delivery, generating value and energy savings, apart from traditional utilities and load serving entities;
  - Electrification, Decarbonization and Distributed Energy Policy Objectives compelling material changes in regulatory responses to meet new power system, customer and societal needs;
  - Growing Digitalization with "Smart" technologies (information, communications and control technologies) that enable visibility, forecasting, intelligence, flexibility, integration and interoperability; Enable, through intelligent interconnectivity, multi-fuel/resource, multi-device/equipment uses and integrated energy solutions by means of RT market interactions;
- **Nature and Pace of Change fundamentally impacting Grid and Community Parameters; Players and Market Interactions; and Regulatory Structures, Roles and Responsibilities**

"INTEGRATED GRID" MODERNIZATION FRAMEWORK

- **High VER and DER will materially change the technical, operational, environmental and financial character of electricity sector (EPRI); fundamentally change the way in which utilities plan, operate and innovate (Kristov, Erickson, et. al.). An "Integrated Grid," one that optimizes the electric power system, while providing safe, reliable, affordable and environmentally responsible electricity, must address the following key areas (EPRI):**

- ***INTERCONECTION RULES, COMMUNICATION TECHNOLOGIES AND STANDARDS:*** Interconnection Rules to preserve voltage support and grid management; Situational Awareness in operations and long-term planning; ICT to allow seamless interconnection while assuring cybersecurity; Standard Language, Common Information Model, and Functional Standardization to enable DER interoperability;
- ***ASSESSMENT AND DEPLOYMENT OF ADVANCED DISTRIBUTION AND RELIABILITY/RESILIENCE TECHNOLOGIES:*** Smart Inverters/IBRs to provide voltage and frequency support, communicate with energy management systems, utility compatible and grid-interactive; ADMS to fuse power and information; Distribution Energy Management Systems and Sensors to integrate/manage DER and intelligent devices, while also interconnecting with Transmission resources in real time; Distributed Energy Storage, Demand Response, Microgrid Systems integrated with energy management systems;
- ***INTEGRATING DER/VER INTO GRID PLANNING AND OPERATIONS:*** New Tools and Methods for integrating DER/VER into planning (forecasting load growth and DER growth; hosting capacity; locational net benefit analyses, etc.), no longer "fit and forget;" BC/Analytical Framework for DER Valuation; Reduce Information Asymmetries, Data exchange/coordination protocols with DER owners/operators, software developers, etc.; Re-define roles/responsibilities of DSOs and RTOs/ISOs;
- ***ENABLING REGULATORY FRAMEWORK:*** Capacity-related cost requirements; State Economic Regulatory Reforms; Power Market Rule Reform to assure long-term resource adequacy and Both to integrate DER/VER; Responsible Cost Recovery and Allocation using Market mechanisms; Leverage market participation of customers/third parties to meet new electric power system, customer and societal needs.

(Adapted from EPRI, "The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources" (2014) Holistic Approach

NEW ELECTRIC UTILITY REGULATORY PARADIGM

- **Re-Alignment of Utility Financial Interests and Performance with Long-term Customer Value;**
- **Reduce Legacy Regulatory Barriers; Level the Playing Field for All Resources; Capture the Value of New Resources, Enabling Smart Technologies/"Grid Enhancing Technologies;" and Innovative Energy Management Strategies;**
- **Address new uses of Distribution Networks, changing Customer Needs and new Drivers of Network Costs; Procure Cost-Effective Alternatives to Traditional Investments; Facilitate increased Competition in end use service delivery by a variety of New Market Entrants;**
- **Move from a Legacy Paradigm based on Asset Development and Commodity Delivery to Value Creation and Services Delivery; Maximize delivery of Value at all temporal/spatial scales;**
- **Bring Demand Side Resources/Load Management in parity with Energy Supplies in Balancing Supply and Demand;**
- **Distribution System Operator to respond to dynamically changing market conditions** (High DER/RE) **and address customer-facing resources through Proactive Network Management** (Expanded Distribution Planning, Re-structured Operations, Capacity for Market Operations/Market Platform for facilitating Products and Services); Outcome-oriented, with capability to harness cost-savings enabled by DER/load management, smart technologies and active network management strategies;
- **Leverage participation of new Market Players to deliver value and generate energy savings; Co-optimize** multi-actor, multi-use, multi-objective, multi-function investment decision-making;
- **"Integrated Grid" Operating System Harnesses Transactive Energy/Market Marginal Cost Pricing to Value Power System-based investments and Operational Protocols to drive Distribution Utility efficiency and innovation; Interoperability and Integration that enable standardized use of DER/RE/Microgrids throughout the electricity value chain.**
- **Re-define Grid and Market Boundaries to increase the efficient and reliable provision and consumption of electricity services, improve overall social welfare (MIT, "Utility of the Future," (2016)**

REGULATORY RESTRUCTURING FOR A NEW UTILITY BUSINESS MODEL

Reform Cost of Service Model:

- **Overcome outdated legacy assumptions** (customers little role to play in addressing system needs (legacy regime based on one-way power flows, inelastic demand, and predictable aggregate demand); centralized generation and bulk transmission invariably yield cost-effective results) and **remove embedded barriers** impeding attainment of new goals, grid modernization and the market access of new resources;
- **Reform Utility Revenue Model and Re-Align Utility Financial Interests:**
  - **Address limits of traditional CoS and Rate of Return regulation that focuses on capital spending tied to unmanaged peak loads;**
  - **Shift focus from historically incurred costs to pursuit of LT customer value; the past is no longer an accurate guide for the future; Multi-year Business Plans to spur productive efficiency, while assuring allocative efficiency;**
- **Rate Design to Send more Accurate Economic Signals into Market:** Unbundling costs; Cost-reflective rates (Move from TOU/TVR to Dynamic Pricing); D;, Unlock Demand Flexibility with fair Customer DER/DR compensation;
- **Address Information Asymmetries; Promote Data Access, Transparency and Sharing;**
- **Assure Fairness and Equity to all Customers.**

EMBEDDED LEGACY BARRIERS

- **Legacy System Assumptions:** (1) Customers have little role to play in addressing system and ratepayer needs (legacy regime based on one-way power flow, inelastic demand and predictable aggregate demand); (2) Centralized generation and bulk transmission invariably yield cost-effective results;
- **Legacy Regulatory Compact's "Risk/Reward" System:** Incents Utilities to deliver a homogeneous commodity, reliably and efficiently, based on investment in capital intensive infrastructure to support a centralized generation and bulk power system in order to achieve economies of scale and provide universal energy access; Rate of return based on capital expenditures tied to meeting unmanaged maximum peak load (profit motivation); Cost recovery based on volumetric sales of electricity (profit achievement); Historical Least Cost Revenue Model;
- **Legacy System Structural Bias:** Centralized Model, with Fossil Fuel inflexible, Baseload Design, underwritten by "cost of service" regulation, subject to linear constraints; Utility Distribution System not designed to provide proactive network management in response to dynamically changing market conditions;
- **Legacy System Market Structures and Products designed to support Centralized Model:** Previous Wholesale Power Market Participation Models reflected physical/operating characteristics of conventional generation to serve end-use load; Limited large Market Players; Limited, undeveloped retail markets that are not designed to value distribution system based investments.

RE-ALIGNING UTILITY BUSINESS PRACTICES

Level the Playing Field for RE, DER and Microgrid Resources:

- **Equalize Treatment of Capex and Opex –** Spur optimal combinations of capital and operating expenses; allow for innovative energy management strategies; incent continuous performance improvements and innovation;
- **Procurement of most Cost-Effective Solutions to Meet Customer, System and Societal Needs –** Indifferent to source, including non-regulated, third-party and customer capital; Responsive to Desired Societal Outcomes, including sustainability and clean energy policy objectives;
- **Develop Performance Metrics and Incentive Mechanisms to Tap into Net Benefits of DER, RE, Microgrids –** Use Shared Savings Mechanisms tied to Performance Outcomes to allocate risks between utility shareholders and ratepayers;
- **Develop Systematic, Consistent and Verifiable Valuation Methods –** Address the unique physical and operating characteristics of DER, RE, and Microgrids; Develop a Benefit-Cost Analytical Framework to evaluate and measure Utility System, Host Customer/Program Participant, and Societal impacts; Develop Integrated Distribution Resource Plans that account for the locational value of DER, RE, Microgrids within Utility planning, investment and operations and incorporate best practices;
- **Address Distribution System Operational and Infrastructure Capability and Functionality –** Evolve an Integrated Grid to enable and secure DER/Microgrid-provided value;
- **Standards/Protocol Development and Implementation –** Address interconnection; two-way power, information and transactional flows; Reliability, Safety; Appropriate Protection, Communications and Control Systems;
- **Move towards Dynamic Pricing and away from predominant reliance on Administrative Processes; Increased reliance on Market-based solutions and mechanisms; Transactive Energy/Local Energy Markets.**
- **Reduce burdens on BPS and Enable Community-based decarbonization multipliers –** Optimize local energy to defer costly utility-scale investments; increase utility system asset utilization; build grid and community resilience; incent cost-effective higher value applications and performance.

INCREMENTAL OR FUNDAMENTAL CHANGE

Legacy Asset Development/Commodity

- ***Single Fuel/Single Device/Equipment***; Grow/Build-Out to meet Peak Demand; Commodity Delivery; Energy Supplies
- ***"Natural Monopoly": Utility Triggers, Franchises, Rights of Way:*** Business Model Classifications; Utility O/O; Hybrid/Distribution Leasing; Exemptions, Safe Harbors (PURPA, QFs);
- ***CoS Regulation:*** Decoupling/Lost Revenue Adjustments; Shared Savings Mechanisms; Value-Adding Services;
- ***Tariff Structure/Rate Design:*** TOU, DR, Cost-Reflective, Unbundled, Technology Service Value;
- ***Performance Metrics:*** Policy Mandates; Technology and Fuel-Specific (support Utility-scale; Project vs Market

Customer Value/Electricity Services

- Multi-Use Applications; Integrated Energy Solutions with Intelligent Interconnectivity, Advanced Controls
- Performance-Based, Cost-Effective Options Regardless of Ownership or Business Model; "Public Interest" Value Generated based on Capabilities/Benefits (Consumer, Utility, Community, Society);
- Shift from historical to forward looking; from volumetric sales to LT customer value; Multi-Year Business Plans; Equalize treatment Capex, Opex;
- Dynamic Pricing; Moving from Administrative to Market-based Solutions; Value of Services to Grid, Community, Market; Local Energy Market
- Performance Metrics for DER and Microgrids; Reliability and Resiliency; "Systems" EE, Clean Energy, Sustainability

INCREMENTAL OR FUNDAMENTAL CHANGE

Legacy Asset Development/Commodity

- ***Utility Planning:*** Integrated Resources Plans;
- ***Resource Valuation:*** Technology Specific; Host-capacity; Net Local Benefit Analyses;
- ***Market Access:*** Existing Framework; Product Definitions; Aggregating, Stacking Values (Legacy Bulk Power)
- ***Clarify Interconnection, Fees, Technology Tariffs:*** Simple, Faster, Fairer
- ***Openness of Utility Network:*** Limited Access to Data, Information Sharing

Customer Value/Electricity Services

- Distribution Resource Plans Integrated with IRP; Integrated Planning T, D and Customer Applications; Plans distinguish DER, Microgrid Delivery; "Platforms"
- Value of Services to Grid, Market and Community, take into account unique physical/operating characteristics; Locational Value; Uniform, consistent, verifiable BCA methods;
- Pricing Accuracy, Granularity; Flexibility; New Participation Models; "Optimization;" Multi-Function Resources;
- Interconnection, Tariffs based on "Value" of Services/Grid Impacts, not size; Standby and Exit Fees Exemption; Standardized Interconnection; ES, Microgrids;
- Transparency with Protections; Information Sharing Protocols; New DSO roles, responsibilities

TRANSITIONING to CAPTURE "VALUE"

- **Regulatory and Market Reforms** recognize unique physical and operating characteristics of Advanced Microgrid Systems ("AMS")/DER; capture the full range of benefits of **Energy and Resource Efficient "Systems";**
- **Consistently Definitions; Differentiate Resources based on Physical and Operating Features;**
- **Standardize Layered Control and Communications Infrastructure:** Move out of "Niche" applications to "Market Mainstream" (Standardize Architecture, Customize Design);
- **Move from Asset-Based to "Value-Based" Rules;** from Homogeneous Commodity to Heterogeneous Services;
- **Value-Based Reform** to credit/monetize the cost-effectiveness of higher value applications (performance/efficiencies); Maximize value delivery at all time/locational scales (technology-specific to integrated solutions);
- **Address AMS/DER Value Creation as part of Grid Modernization**;
- **Address AMS/DER Value to Shape an "Integrated Grid" that Evolves "Integrated Local Energy Networks" in Communities;** Capture synergies at Grid and Community Levels; Enable Energy to be managed seamlessly and interchangeably;
- **"Smart Grid," "Smart Microgrid," "Smart Communities":** Optimal Energy Use and Investment.

REGULATORY INNOVATIONS

- **"Performance-Based Regulation" to capture Value: Shift from focus on historically incurred costs to achievement of long-term customer value; Equalize capex and opex, place load management in parity with energy supplies in balancing supply and demand, incent continuous improvements in performance/efficiencies and spur innovation,** including assigning DSO targeted levels of reliability and resiliency and enabling Distribution System to make more efficient demands upon the bulk power system (BPS) **(**HI PBR Framework and Principles**:** Performance Metrics/Performance Incentive Measures; Earnings Adjustment Mechanisms; Multi-Year Business Plan; Earnings Sharing Mechanisms/Risk Allocation**)**

- **Efficient Pricing and Charges/Tariffs towards "Dynamic Pricing":**
  - **Disaggregated framework of "nodal" pricing**, valuing decentralized energy decisions, based on local and time differentiated distribution network constraints; DSOs provide disaggregated nodal pricing to promote optimal allocation of scarce network capacities, differentiating allocation issues at different network voltage levels and differentiating different timing perspectives (Knieps, Disaggregated Nodal Pricing); (NY REV VDER Proceeding, Retail Tariff based on LMP + D + E)
  - **Move towards rates based on marginal cost to power system** attributable to a customer's energy usage/investment decisions;
  - **Evolve "Value-Based" Pricing** that monetizes the cost-effectiveness of higher value applications (performance attributes and efficiencies) to maximize value delivery at all time/locational scales (technology specific to integrated solutions); Reflect long-term avoided costs and real-time value of services (Grid to Customer; Customer to Grid; Customer to Customer);

REGULATORY INNOVATIONS

- **Increase Spatial and Temporal Granularity in Valuing and Compensating DER/Microgrids:** Consistent Valuation, Verifiable Measurement and Monetization of DER/Microgrid System Benefits/Costs as part of an Integrated Distributed Resources Planning Framework and evaluation of Non-Wire Alternatives; (CA DRP Elements: Hosting Capacity; DER Locational Net Benefits Analysis; DER Grid Integration; Distribution System Operational and Infrastructure Capability to convert DER value; DER Growth Scenario Analyses); (NY "REV" B/C Analytic Framework);

- **DSO Active Network VER/DER Management;** New Distributed Energy Model with functions akin to Transmission level, managing distribution planning, investments and operations; harness net benefits of DER to bring "Flexibility" to Generation, Delivery and Use, maximizing efficiency and minimizing costs of delivering reliability at all time/locational scales; More efficient demands on Bulk Power System;

BUILD MARKET CAPACITY AND CUSTOMER ENGAGEMENT

- **Change Utility "Risks/Rewards" to pursue Cost-Effective Solutions indifferent to sourcing;**
- **Increase Reliance Upon Economic and Price Signals to motivate Investment and Operational Decision-making and Price-Responsive Customer behavior;**
- **Build capacity for Market engagement and to increase Competition, consistent with reliability, affordability, safety and equity;** Modify Customer Behavior using new technologies and analytics;
- **Design Market Rules and Mechanisms to value system-based investments and operational protocols,** to drive utility efficiency, reliability and innovation based on customer demand and expectations; **Administrative to "Customer and Data-Driven Market Paradigm" Shift** (NY REV)
- **Market Design: Move from Asset Development to Value Creation; from Commodity to Service Delivery in evolving an "Integrated Grid;"**
- **Increase Transparency, Reduce Information Asymmetries, Disseminate Material Information with appropriate Privacy and Security safeguards.**

MARKET PLATFORMS

- **Multi-Sided Market Platforms:** Enable transition, innovation, retail market integration and transactive interaction: (1) Embrace diverse party collaboration/participation; (2) Foster mutually beneficial relationships; (3) Promote transparency, material disclosure of information, and robust utility, customer, third party communications; (4) Enable rapid adaptation and response to changing market conditions; (5) Continually integrate new products and services, users, vendors; (6) Use cloud technologies and data analytics to offer "personalized"/heterogeneous services; (NY REV)
- **Market Platform to Generate Service Optionality/Merging Adaptability and Flexibility with Continuity and Stability:** (1) "Operational Platform"/Infrastructure – Transform System Operations fusing power and information (automating, optimizing and interconnecting power system functionality and "smart grid" functions (DA, DR) with customer site-based power systems and load management); (2) "Market Platform"/Connectivity -- Interface or Network with burgeoning distributed energy nodes and prosumers to enable energy services; (3) Unlocking value from technology innovation and new business models;
- **IoT/IT Elements:** Computational and Internet technologies; "Cloud" technology; Mobile devices and apps; Social Networks; Data Management and Analytics;
- **Transitioning**: Commodity Infrastructure Services; Enhanced Commodity Services; New Basic/DER Services; Advanced Platform Services; Customer Maturation Process [John Cooper, Innovation Platform Enables IoT]
- **Examples: NY REV DSP for Competitive Offerings of Products and Services: Avista Utility Platform**

SMART GRID, MICROGRIDS, COMMUNITIES for Efficient Community Energy and Resource Integration

- **Align Utility and Community Processes for Resource Planning and Development:** Incorporate energy S/D infrastructure analyses of alternative energy and resource development options into housing, land-use, water supply and wastewater, transportation, waste recycling and reuse and other municipal processes; strategically site and permit Microgrids (cluster compatible uses, build local energy networks mutually beneficial to the grid and community);
- **Interrelate/apply "Utility" Decision Support Tools & Methods with Local Decision-making Tools and Methods in Community Integrated Energy Systems Demonstrations** to develop Use Cases and Scenario Analyses;
- **Redesign "Community Choice Aggregation:"** Economic and Financial means for optimizing the mix of local and bulk energy;
- **New Governance Structures, Incentives, Service Provider:** Micro-Municipalization; Net Zero Districts, Zones or Hubs; Microgrid Integrated Energy Services Provider
- **"Community-Scale" Clean Energy and Energy Efficiency Standards for Land-Use Planning and Development (and related to Energy Assurance and Emergency Planning, Response and Restoration)**
- **Build constructive Partnerships between Military Bases, Communities and Utilities**

SHAPING A NEW GRID OPERATING SYSTEM

- **"Integrated Grid":** (Hawaii Grid Modernization Framework/**Grid Architecture**)
  - **New Parameters – DER Integration --** take fully into account and value DER in Utility Planning, Investments, Operations and Trading; **Expanded Electricity Value Chain Parameters –** Changing Grid and Market Boundaries; **"End to End" Interoperability –** Standardize DER/VER use throughout Electricity value chain;
  - **New Market Players –** Prosumers, Third Parties, Microgrid System Operators, DER Aggregators; Energy Service Providers, System Integrators, etc.
  - **New Regulatory Structures –** New Utility Business Model and Market Design to achieve policy objectives, while maintaining reliability, safety and affordability;
- **Cyber Secure-Physically Resilient Grid Architecture:** Highly flexible, configurable, modular, interactive and dynamic networks of utility, customer and third party applications; Market data, price signals and transactions; multi-directional power, information and transaction flows; and "System of Systems" Layered Infrastructure for DER integration and load-side management; New Grid Operating System vital to realizing the full value of distributed resources and utility-scale renewables, as well to achieve cost-effectively policy objectives;
- **Grid Design to Leverage Local Integrated Energy Development and Use:** Increase independence, flexibility and intelligence for optimizing energy use and management within local energy networks and integrate local energy resources into a Smart Grid and Market [EPRI, "Needed: A New Grid Operating System to Facilitate Grid Transformation"];

SHAPING A NEW GRID OPERATING SYSTEM

- **Building Technical, Informational and Organizational Interoperability:** (1) **Technical Interoperability** – Standards for physical and communications connections between devices and HEMS, HEMS and smart meters, and DERMS, Microgrid EMS and Distribution Management Systems; (2) **Informational Interoperability** – Standardized content and format for data or instruction flows (OpenADR, Zigbee, etc.); (3) **Organizational or Process Interoperability** – Includes market structures, pricing models, regulatory structures; **(Eg., "HEMS" (Pecan Street Project)/"Energy Boxes" (MIT)/ "Prices to Devices" PNNL –** Enhance customer cost-savings and satisfaction; drive commercial opportunity; and enable utility to meet reliability/resilience, system efficiency, and environmental goals);
- **Maximizing Value through Intelligent Energy Management and Control Strategies: "System of Systems" Layered Architecture; Advanced Microgrids; Integrated Local Energy Networks:** Agent-based, layered communications/controls (Device Level; Site-Level; Grid-Level Agents) (Utility; Microgrids);
- **Developing a New Grid Operating System: "Core Cyber – Physical Resilient Grid Platform" –** Identify Advanced Grid capabilities to address new power system and customer needs to achieve societal policy objectives; Define Core Platform components and structure Grid Architecture to enable requisite planning, operational and market functionality [USDOE, "Modern Distribution Grid Decision Guide"]

SHAPING A NEW DISTRIBUTION SYSTEM MODEL

- **Proactive Distribution Network Management:** Respond to dynamically changing market conditions and manage customer-side resources (**Distribution System Operator);** Transmission System-like functions to manage distribution planning, investments and operations:
  - **Maintain Reliable Operations with two-way, multi—point reversible power flows with increasing volume, diversity of DER;**
  - **Integrate and Balance DER and Load to shape load profile and peak demand;**
  - **Achieve Functional control of DER for real-time balancing and flexibility and grid services;**
  - **Define/Manage Transmission/Distribution Interface;**
  - **Address Changing Characteristics of New Resources and Changing Nature of Customers (Kristov, Erickson, et al., "Distribution Planning")**

- **Smart Technologies Enable TE and Distribution Grid Modernization:** Smart information, communications and control technologies; Distributed Intelligence and Data Management and Analytics; Distribution Automation; Algorithms, Machine Learning and Artificial Intelligence;
- **Advanced Distribution Management Systems:** AMI, OT/IT Integration; Automated Distribution Management Systems; Distributed Energy Resource Management Systems (sensors, communication and computational ability/modeling, simulation, analytical and diagnostic tools and methods for proactive distribution control model);
- **Leverage Grid-Compatible and Market Participation Protocols to facilitate decentralized dispatchability and "peer to peer" transactions; optimal mix of local and bulk energy;**
- **New Market, Customer and Data-Driven, Services-Oriented Model:** Customer choice and decision-making to "value" system-based investments and operation protocols that drive utility efficiency and innovation.

NEW REGULATOR ROLES AND RESPONSIBILITIES

- **Proactive Role –** Address Barriers; Delineate Enabling Frameworks; Create Environments that take into account and balance all relevant stakeholder interests and that are conducive to consensus-building; Promote alternative analyses;
- **Facilitate Managing Risk and Uncertainty;** Forward Planning (past no longer a gauge of the future); Support appropriate new Tools and Methods in Utility planning and decision-making to assess impacts and the costs-benefits of utility and other proposals in responding to system, customer and societal needs; Interrelate System Planning, System Operations and Market Operations; Employ Grid Architecture Discipline;
- **Facilitate Transitioning to 21st Grid and Markets, supporting –** Integrated Distribution Resource Planning and Operations; Active Network Operating Management; Support of Distribution System Level Market Operations; Expansion of Grid and Market Services; Leveraging new Market Actor participation to deliver value; Retail/Wholesale coordination/cooperation; Optimal Distributed and Centralized Resource Mix; Reduction in Information Asymmetries, Data-Driven modernization with data sharing protocols, Increased Transparency with Privacy and Security Safeguards; Protections against Abuse of Market Power and Conflicts of Interest;
- **Enhance Stakeholder Processes –** Using a wide range of regulatory venues alternative to "rate cases" (rulemaking proceedings, workshops, technical conferences, etc.);
- **Access sources of Technical Assistance** (i.e., USDOE, National Laboratories, National and State Energy Offices, Industry, NGOs, Academia, etc.)
- **Support holistic strategies, public-private partnerships; retail/wholesale coordination; electric industry and community cooperation**

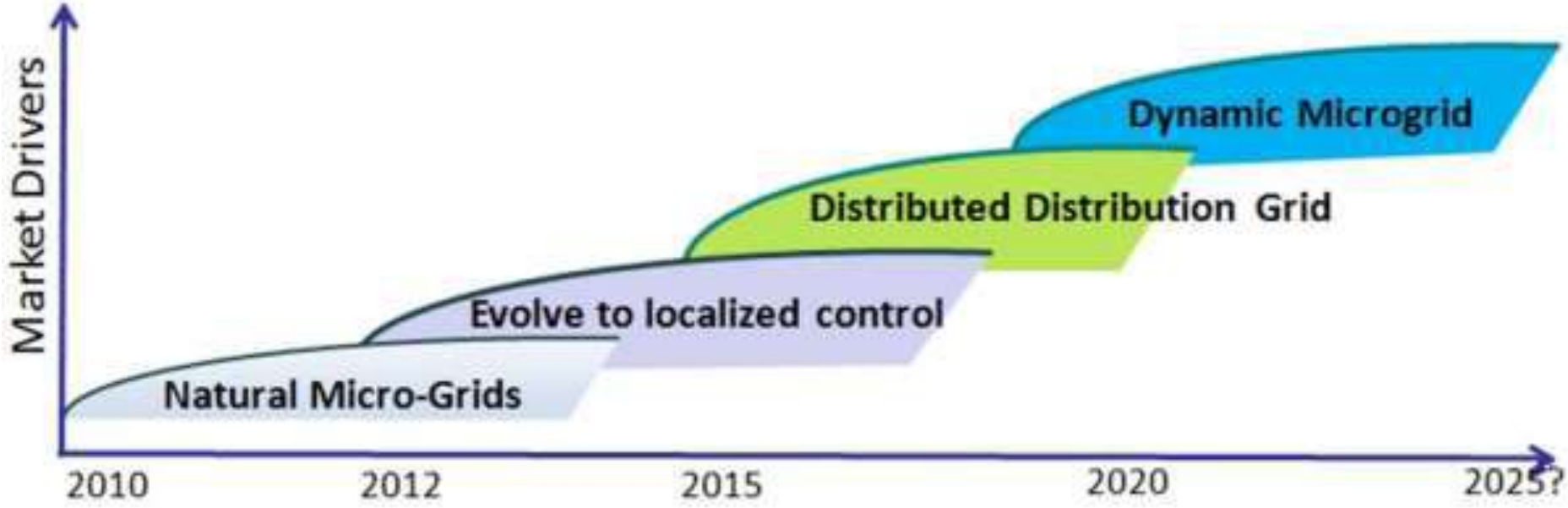
REGULATORY SUPPORT FOR SANDBOX DEMONSTRATIONS

- **Apply New Modelling & Simulation Tools, Analytical Methods at Testing Facilities and in "Testbed" Demonstrations:** (1) Validate functions of DER/Microgrids to relate to value streams and quantify/estimate net benefits (economic, reliability/resiliency; power quality, environmental, security and safety); (2) Support open source architecture, standards, protocols and configurations to achieve interoperability, integration, flexibility and spur competitive market opportunities; (3) Shape Pilot Planning, Design and Implementation; Perform Scenario Analyses of different Market Structures and Business Models and Compare Cost-Effectiveness of Alternative Scenarios with Traditional Investment Options and with each other; (4) Assess Barriers and Challenges;
- **Evolve Uniform, Consistent, Verifiable Valuation Methods and Cost/Benefit Analytical Frameworks** to quantify system, customer and societal net benefits of DER;
- **Apply Relevant Standards to Demonstrations:** Related Standards issued by such Standards Development Bodies as IEEE (1547; 2030.7, 2030.5, etc.);
- **Design and Implement Demonstrations of Distributed System "Platforms:"** Evaluate distributed systems architecture for optimizing dynamic sets of DER/VER across the diverse infrastructure and built-environment of a community;
- **Interrelate and Leverage Utility Decision Support Tools & Methods with Local Decision-making Tools to** evolve Advanced Energy Communities and Integrated Energy Solutions that support Customer to Grid, Grid to Customer and Peer to Peer interactions;
- **Technical Assistance to Regulators** to help identify; stage/sequence and establish key performance criteria for pilots to inform transitioning with respect to decision-making processes; cross-agency cooperation and coordination (State Energy/Environmental Offices; Office of People's Counsel; Special State Evaluators; GSA, etc.

PATHWAY: Interconnection to Integration to Intelligent Interconnectivity

- Iterative and Staged Pathway (from physical interconnection to Energy Internet/IoT for Shared Energy Economy): Change utility regulatory paradigm to spur value creation, measurement and compensation; Evolve "interoperability" and integration (technical, informational, organizational) within entire power value chain to unleash opportunities for new microgrid/DER business models.

Source BNL: Roadmap to evolve dynamic, grid-compatible and interactive microgrids, Sandia Advanced Microgrid Report



Interconnected Smart Districts