"Advanced Microgrids":
Changing Parameters, Players and Rules

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Larisa Dobriansky
General MicroGrids
Chief Business & Regulatory Innovations Officer
Larisa.Dobriansky@gmail.com

ADVANCED MICROGRIDS

- **Advanced Microgrid Capabilities:** Co-optimizing Benefits for Customers, Grid, Markets and Communities
- **Changing the Regulatory Paradigm to Capture "Value"**: Shaping New Parameters, Players and Structures
- **Shaping a New Grid Operating System and Market Design**
- **Accelerating Advanced Energy Communities**
- **MaaS Business Model: Capturing "Value"**
- **Institutionalizing New Roles and Governance Structures within Communities**

Advanced Microgrid Systems (AMS) Capabilities: Transforming Power System and Community Energy Infrastructure

- **Intelligent Electricity Delivery Network** that interconnects, interoperates, **optimizes,** orchestrates **loads, DER and storage**, using layered controls and communications, within defined electrical boundaries that acts as a single controllable entity with respect to the macrogrid at the point of common coupling; Can island, connect, disconnect from grid to enable it to operate in both grid-connected or island modes; Balances demand with supply in RT; Schedules dispatch of resources; Preserves grid reliability; **Intelligently managed, energy/resource efficient System;**
- **"Smart System of Systems" -- Managing and Integrating, through Advanced Controls and Communications, Multiple Distributed Resources as a "System;"** Agent-based, layered Communications/Controls (Device Level; Site-Level; Grid Level Agents) provide seamless integration, interoperability and optimization of disparate systems, technologies and applications;
- **Intelligent Load and Energy Resource Management:** Maximize use of D/S assets; Minimize costs through efficiencies; Resource and Load Profiling, Prioritizing, Controlling Forecasting; Master Controller for resource/load optimization;
- **Self-Healing –** Detect, analyze, respond and restore itself in case of disruptions, self-configuring.

INTELLIGENT DISTRIBUTED ENERGY MANAGEMENT and DELIVERY SYSTEMS

- **Intelligent Local Energy Management:** Diversify resources; optimal infrastructure to meet energy requirements (power, heating and cooling); local control of resilience and sustainability;
- **Clustering Compatible Loads and DER Units:** Manage and optimize dynamic sets of distributed and intermittent resources within an integrated, autonomous system, using microgrid controllers, to provide **intelligent energy management and smart delivery;**
- **Distributed Networked Electricity Systems:** Microgrids can be connected to each other and to bulk power system; Sharing generation, controllable load and storage capabilities over wider areas for optimal energy and risk management;
- **C/E Distributed Control: "**Integrative Business Model" can yield increased electricity performance through enhancing DER value, reducing burdens on Grid; C/E power quality, availability, reliability/resiliency, efficiency and "heterogeneous" benefits.

SMART MICROGRID DRIVERS

- **Technology, Policy and Market Changes**
- **Energy Surety and Resiliency:** Ability to withstand outages; assure available supply to meet requirements; harden critical infrastructure/assure delivery of essential community services;
- **Economic Competitive Advantage:** Defer/avoid T&D investment; Cost-effective district/regional planning alternative to transmission siting challenges; optimize capacity and add value (DER/Load management);
- **Manage/Shape Peak Load Demand:** Cost-effective distributed resource control; peak power availability; shape load curves;
- **Environmental and Efficiency Goals:** Lower environmental emissions; increase use of renewable resources; efficient fuel use; increase efficiencies using waste heat; improve local control and increase self-reliance;
- **Sustainable Economic Development** and job growth;
- **Growing Digitalization, Electrification, Distributed Energy** providing a new context for local energy development/management.

UNCERTAINTIES, BARRIERS AND RISKS

- **Technical:** Moving from “niche” application to “market mainstream; replicability, scalability; Standardizing Technology & Business Framework for microgrids;
- **Economic:** Establishing a Business Case; Monetizing value streams; Developing “bankable” projects; Increasing Market Access; Improving Project Economics;
- **Policy and Regulatory:** Combining decentralized/distributed elements with centralized components; Moving from meeting peak capacity to load profiling, from “grow and build out” to “value creation;” Defining microgrids; Addressing “utility” triggers and franchises; Re-delineating monopoly vs competitive domains; Building customer acceptance and engagement;
- **Institutional:** Centralized paradigm institutional structure; Lack of Technology Standards/Requirements, Infrastructure and Interoperability; Incompatible Market and Pricing Structures; Lack of Cost-effectiveness and Valuation Methods; Lack of Integration into Utility Planning, Investment, Operations and Trading;
- **Continual Change, Increasing Pace of Technology Innovation, Information Asymmetries.**

BASIC BUSINESS MODEL CLASSIFICATIONS

- **Crossing Market Segments: Small Commercial and Residential; Commercial & Industrial; Rural Electrification** (Design customized to local circumstances/energy requirements; mixed-use development);
- **Community Microgrids could combine different Business Models;**
- **Single Customer** (contiguous property);
- **Single Customer/Campus/Institutional** (contiguous and non-contiguous property);
- **Multi-Customer, Multi-Use, Grid-Connected** (non-contiguous properties);
- **Multi-Customer, Multi-Use, Grid-Compatible and Interactive** (Advanced Microgrid functions at PCC beyond basic connection/disconnection from Macrogrid);
- **Ownership and Asset Management:** Customer, Cooperative; Landlord/Tenant; Third Party; Utility; Hybrid
- **"Public Purpose" Microgrids**
- **"Advanced" vs "Traditional" Microgrid** (Scale, Cost, Reliability and Security, Performance, Scalability differentiating factors)

REGULATORY ISSUES AND IMPACT AREAS

- **Definition of Microgrids (Advanced Microgrid);**
- **Microgrid Ownership and Asset Management;**
- **Types of Microgrids; Utility Regulation Triggers; Utility Franchises and Rights of Public Way; Exemptions and Safe Harbors;**
- **Utility Cost of Service; Tariff Structures; Rate Design; Incentives to Align Utility interests with achieving new Policy Objectives, while assuring reliability, affordability of service;**
- **Interconnection Procedures, Tariffs, Utility Charges and Fees; Microgrid/Utility Interactions/Protections;**
- **Microgrid Siting and Permitting;**
- **Coordination of Microgrid Policies with "DER" Incentive Programs;**
- **Market Access and more Granular Pricing:** Wholesale, Retail, T/D Interface;
- **Customer Engagement, Rights and Protections;**
- **Utility Access; Information Sharing;**
- **Utility Planning and Valuation Methods;**
- **Utility Roles and Responsibilities in the "Public Interest;" DSO; Monopoly and Competitive Domains.**

INCREMENTAL OR FUNDAMENTAL CHANGE

Legacy Asset Development/Commodity

- ***Definition:*** Standardize definition;
- ***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

Customer Value/Electricity Services

- Define Advanced Microgrid capabilities; Demonstrations/Pilots, Use Cases;
- Performance-Based, Cost-Effective Options Regardless of Ownership or Business Model; "Public Interest" Value Generated based on Capabilities (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;
- 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 (Bulk Power)
- ***Clarify Interconnection, Fees, Technology Tariffs***
- ***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 methods;
- Pricing Accuracy, Granularity; Flexibility; New Participation Models; Services; "Optimization;" Multi-Function Resources;
- Interconnection, Tariffs based on "Value" of Services; Standby/Exit Fee Exemption; Standardized Interconnection;
- 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 AMS vs. generic "DER"; capture the full range of benefits of **Energy and Resource Efficient "Systems";**
- **Consistently Define AMS; Differentiate 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 Value Creation as part of Grid Modernization**;
- **Address AMS 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.

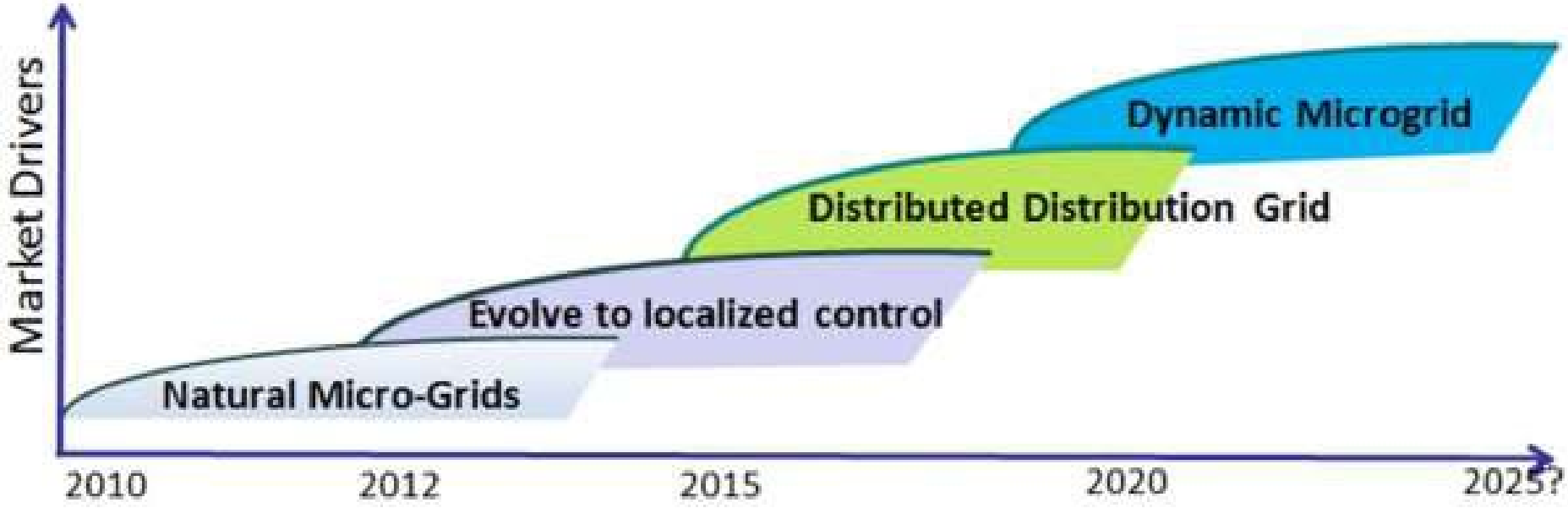
SHAPING A NEW GRID OPERATING SYSTEM

- **New "Integrated Grid" Paradigm: Expanded Electricity Value Chain Parameters;** Integration of new resources/technologies; **New Market Players** (prosumers, third parties in market); **New Regulatory Structures** to change current paradigm and utility business model to achieve policy objectives, while maintaining reliability, safety and affordability;
- **Interactive, Flexible, Modular and Innovative Grid:** Highly flexible, configurable and interactive networks of utility, customer and third-party applications; market data, price signals and transactions; "System of Systems" operations for DER integration and load-side management; All electricity resources treated as primary resources;
- **"Integrated Grid":** Take fully into account and value DER/Microgrid in Utility Planning, Investments, Operations and Trading; Grid Design to increase the independence, flexibility and intelligence for optimization of energy use and management within local energy networks (building, community and distribution system levels) and to integrate local energy resources into the Smart Grid.

PATHWAY: Interconnection to Integration to Intelligent Networking

- 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 business models.

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



NEW UTILITY DISTRIBUTION SYSTEM MODEL

- **NY, CA, other States evolving regulatory frameworks to achieve Policy Objectives and Align Utility Financial Interests to create Long-Term Customer Value:** Regulatory innovations designed to value system-based investments and operation protocols that can drive distribution utility efficiency and innovation; Shift from meeting peak capacity and "building more to profit" to load profiling and optimizing investments; from measuring megawatts sold to measuring value creation; from selling commodities to providing "infrastructure as a service;"
- **NY, CA have set "building blocks" for new "Regulatory Eco-System" to support investment in interoperability and integration on a power system-wide scale, but with a particular focus on Distribution System changes, to standardize the use of distributed and demand-side resources as part of overall power system planning, grid operations and power market trading;**
- **NY, Ca initiatives addressing/overcoming Traditional Legacy Assumptions:** (1) There is little role for customers to play in addressing system needs (inelastic demand; passive customer); (2) Centralized generation and bulk transmission invariably yield cost-effective results (DER/Microgrids outside of power value chain; reliance upon bulk supplies; not tapping into local energy and load management).

EFFICIENT COMMUNITY RESOURCE INTEGRATION

- **Smart Microgrid Infrastructure as "Community Services Platform:"** Manage and optimize local energy across end use sectors (Transportation, Water, Waste, Buildings, etc.), leveraging data sets that span diverse facilities, systems and purposes to interlink and optimize energy-using functions of diverse infrastructure systems and build environment;
- **Interconnect Community Users with Energy-Using Infrastructure**, through new layers of intelligence/ICT, realize benefits of digitalization and electrification;
- **Catalyze Smart Community Development:** Improve individual city operations (individual service level); Integrate related processes and services with smart technologies (vertical service level); Integrate disparate service areas seamlessly within an efficient smart city eco-system (horizontal service level);
- **Locally-based, Smart Distributed Systems Architecture:** Leverage investment to achieve higher levels of performance, while protecting key community facilities and functions during grid outages and energy disruptions; Multi-function resource;
- **Change "Energy Sharing" Parameters:** "Uberize" asset management to support "Convergence" (seamless and interchangeable energy use and management).

MICROGRID AS A SERVICE (MaaS)

- **Expert Solution Providers for "Grid-Connected Communities":** Increase independence, flexibility and intelligence for optimization of energy use and management within local energy networks (facility site, campus or community level), and integrate local energy resources into a Smart Grid;
- **Flexible Ownership Structure:** Allocates risk to parties in best position to assume risks; shifts financial risk from "customer" (customer capital expense) to third party financiers to "diversify" from traditional power services in collaboration with utilities (customer operational expense; no upfront capital costs);
- **Standardized Financing Design:** Enables repeatable, modular and scalable systems, maximizing value and returns, minimizing costs (project development, system design, commissioning, service, support and funding);
- **Capture Synergies of Interoperating Supply, Demand and Storage Assets within "Microgrid System":** Achieve higher levels of performance (cost-savings, efficiencies, resiliency, renewable energy integration, distributed control and management of DER flexibility using cost-effective local production, optimized self-consumption, tariff management optimization and commercial aggregation for wholesale products/services);
- **Debt/Equity Financing Structure (e.g., SPV); Power Purchase/Service Agreement for Offtakers**

NEW ROLES AND GOVERNANCE STRUCTURES

- **Microgrid Integrated Energy Services Provider to "Grid-Connected Communities":** Manage multiple energy-related operations of District Microgrids/Networked Microgrids; act as multi-purpose developer, financier, operator and administrator of energy systems; regulator of building and end-use sector performance requirements; achieve economic optimization at district level of district's facility, campus and community sites; manage microgrid infrastructure "platform" to optimize flexible loads, thermal storage and renewable generation, providing services to both communities and macrogrid; own and operate district distribution infrastructure;
- **Align Utility and Community Resource Planning and Development Processes in "Master Planning":** 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); Integrate Microgrid/DER Planning across Utility Generation, Transmission, Distribution Plans and Customer applications; Integrate Microgrid "Intelligent Energy Management" into State and Local Energy Efficiency, Sustainability/Clean Energy and Resiliency Plans, with new incentives design;

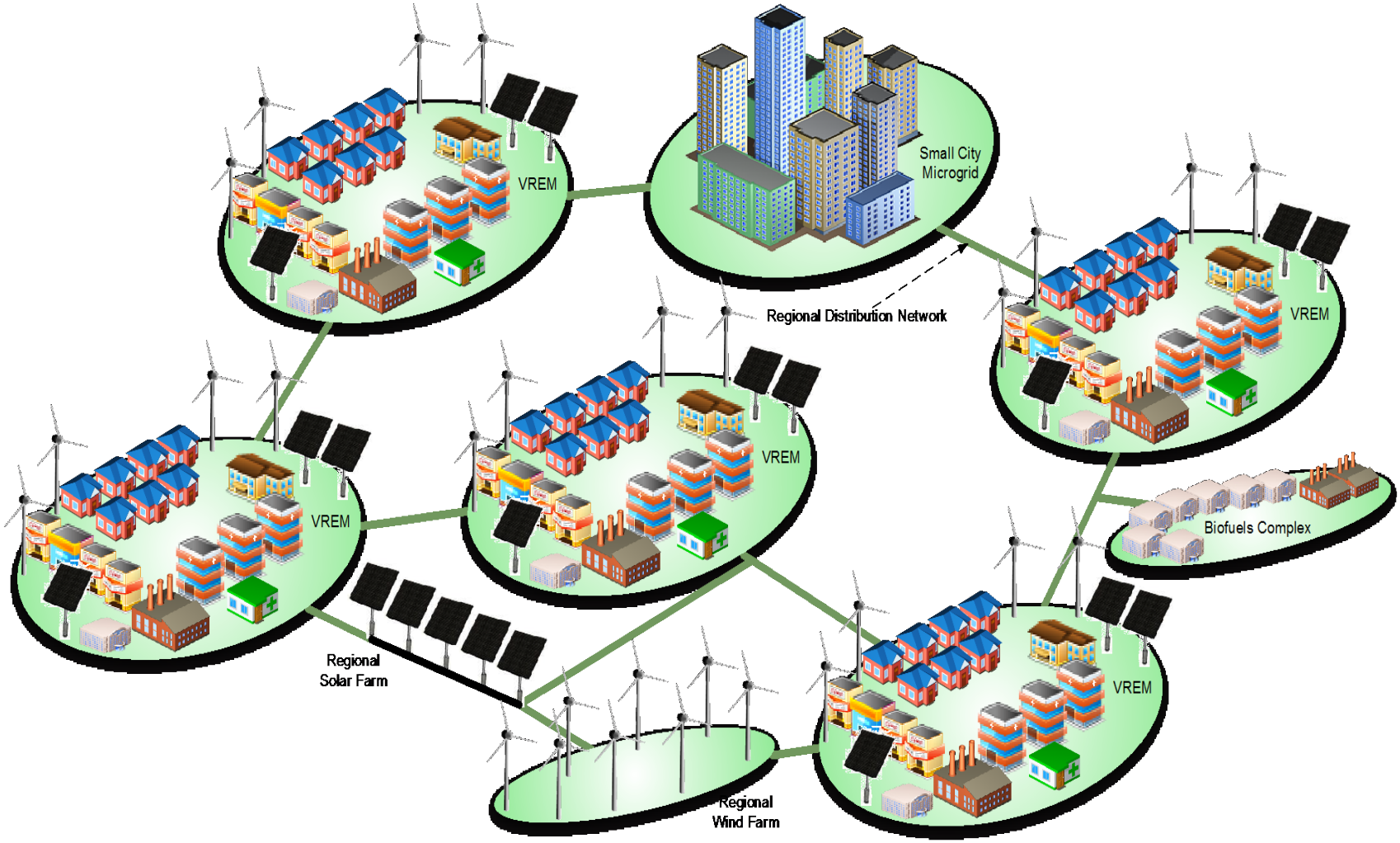
NEW ROLES AND GOVERNANCE STRUCTURES

- **"Community-Scale" Clean Energy/Energy Efficiency/Resiliency Standards for Land-Use Planning and Development,** incenting integrated control management systems;
- **Consistent Valuation, Verifiable Measurement and Monetization of Microgrid "Systems" Benefits and Costs;**
- **Interrelate/Apply "Utility" Decision Support Tools & Methods with "Local Government" Decision-making Tools and Methods in Community "Integrated Energy Systems" Demonstrations** to develop Use Cases and Scenario Analyses;
- **New Governance Structures and Incentives:** Micro-Municipalization; Net Zero Districts, Energy Improvement/Development Zones or Urban Hubs; Incentives for Integrated Energy Solutions and Service Providers;
- **Financing Innovations: Redesign "Community Choice Aggregation" --** Economic and Financial means for optimizing the mix of local and bulk energy supplies; **Microgrid RE/EE Credits; SPV Equity/Debt Structures; Loan Guarantee/Partial Guarantee of Performance; Green Banks.**

DEMONSTRATIONS WITH NEW TOOLS AND METHODS

- **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 Demonstration Planning, Design and Implementation; Perform Scenario Analyses of different DER/Microgrid configurations and Compare Cost-Effectiveness of DER/Microgrid Scenarios with Traditional Investment Options and with each other;
- **Evolve Uniform, Consistent, Verifiable Valuation Methods and Cost/Benefit Analytical Frameworks** to quantify system, customer and societal net benefits of DER/Microgrids;
- **Design and Implement Demonstrations of Microgrid/Networked Microgrid "Platforms:"** Evaluate distributed systems architecture for optimizing dynamic sets of DER/VER across the diverse infrastructure and built-environment of a community;
- **Interrelate Utility Decision Support Tools & Methods with Local Decision-making Tools** for evolving Advanced Energy Communities and Integrated Energy Solutions.

Interconnected Smart Districts



Thank You

Balancing Energy for a smarter, renewable-driven grid

Larisa Dobriansky

General MicroGrids

Larisa.dobriansky@gmail.com

703 920 1377