Transmission-Distribution Coordination to Enable DER Participation in IESO Wholesale Markets

IESO T-D Coordination Working Group, January 31, 2022

Lorenzo Kristov, PhD, Principal Market Architect
Electric System Policy, Structure, Market Design

Outline

- The Ontario IESO Context
- Global DER industry trends and plausible high-DER future system
- DERs in a participatory distribution network; crucial role of the LDC
- The T-D coordination problem
- Grid Architecture logic: objectives, functions, roles & responsibilities
- Centralized versus Layered Architecture
- Brief survey of other regions: FERC Order 2222 & US ISOs, AUS, UK
- Coordination architecture being considered by some US LDCs

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The Ontario IESO Context

IESO DER Market Vision & Design Project

Problem Statement: How can the IESO cost-effectively enhance the value DERs can provide to Ontario's electricity system by expanding participation in the wholesale markets?

DER Definition

A resource that is directly connected to the distribution system, or indirectly connected to the distribution system behind a customer's meter; and generates energy, stores energy, or controls load

The Ontario DER Landscape

- 5000 MW DER deployed already and strong growth expectations
- Customer decarbonization & electrification objectives are a driver
- Community preferences for clean energy
- Growing IESO needs for reliability resources

Global Electricity Industry Trends

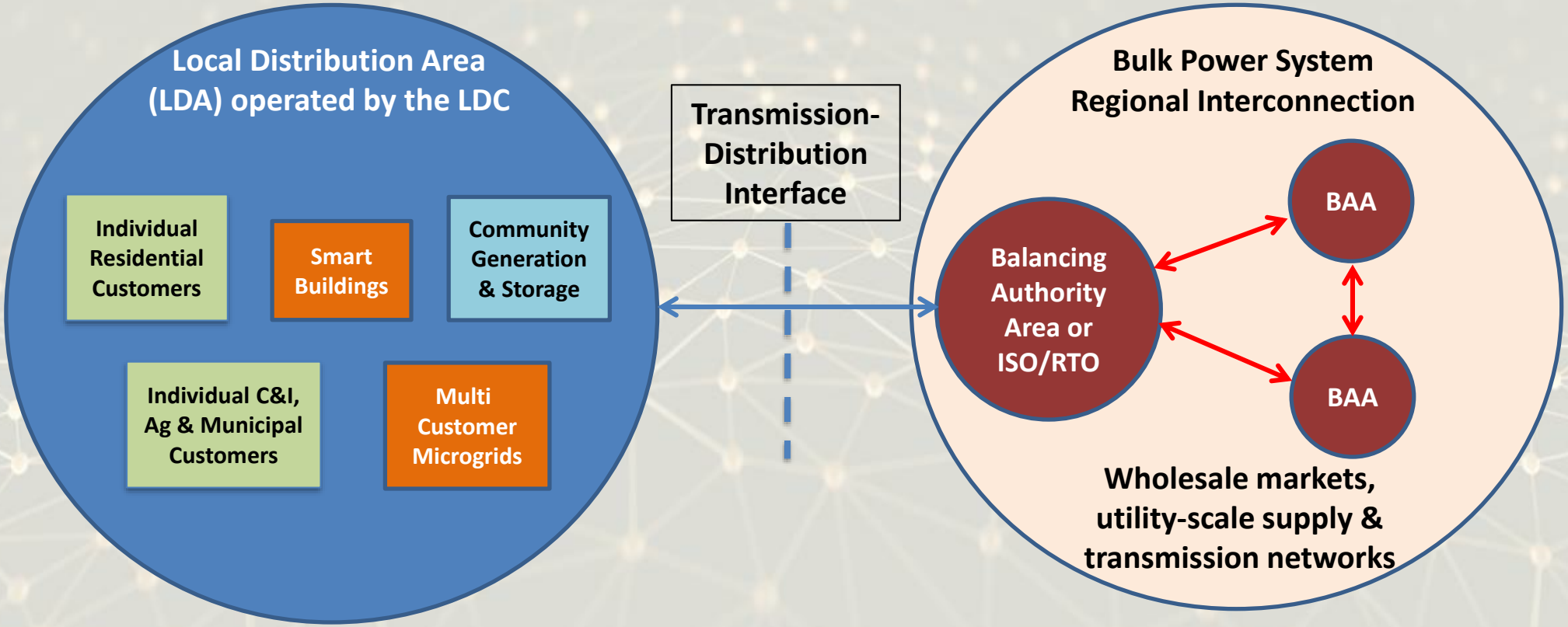
DERs are a global phenomenon, presenting robust competition to ”The Grid” for the first time in 100 years

- DERs continue to improve in performance, functional capability, scalability & cost
- Customers want them: The “behind-the-meter market” offers cost-effective choices for meeting their needs for electricity services
- Local & indigenous jurisdictions want them: DERs & microgrids can support community-level initiatives for decarbonization, resilience and energy/economic justice
- Meanwhile The Grid is becoming more expensive and more vulnerable to service disruptions (climate events, cyber attacks, pre-emptive shutoffs)

The challenge

- Reimagine The Grid to align customer/community DER decisions with system-wide needs and societal goals, to maximize total benefits of DERs

The future "bimodal" system: a diverse participatory distribution network complements the bulk system



- Local resources can supply a major share of new electrification demand
- Distribution network connects diverse customers & community resources
- Customers are grid participants, not just consumers
- LDC manages local grid and may reduce adverse bulk system impacts

- Bulk power system moves renewable energy from production areas to load centers
- Supplements local production and allows regional energy trading

Creating the Participatory Distribution Network

Distribution can no longer be simply a one-way kWh delivery system

- The LDC must enable stand-alone and community DERs and customers with DERs to become network participants and provide services to the system

Compensating DERs for providing system services

- Improves the economics of customer/community DER investment
- Helps align DER investment & operating decisions with power system capabilities & needs, to improve whole-system efficiency

Domains for DER service provision

- Wholesale market services — the focus of this working group effort
- Distribution system services — DERs can reduce grid infrastructure upgrade needs
- Customer services — behind-the-meter DER adoption for customer benefits
- Multi-use applications of DERs (value stacking) — maximizing the value of DERs

Focus on the LDC: ***The high-DER future depends on expanding LDC functional capabilities and establishing coordination with IESO at the T-D interfaces***

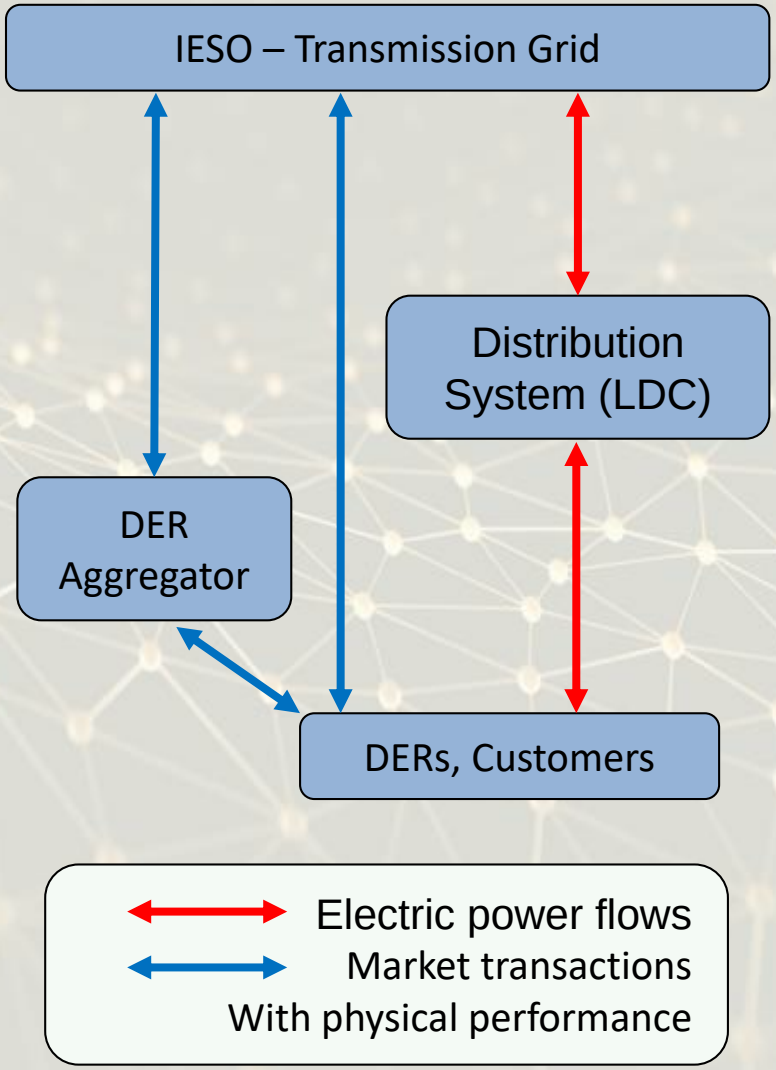
The Transmission-Distribution Coordination Problem

- Direct participation by DER/DERA in the IESO markets involves transactions, **with physical performance requirements**, between the IESO and the DER owner/aggregator; the LDC is not a party to these transactions
- ***Physical performance by DER/DERA to fulfill IESO market commitments necessarily affects & is affected by distribution system conditions***
- "**Tier bypassing** occurs when a device, system, or agent at one level of a grid hierarchy connects to, directs, or controls an element more than one tier away." (PNNL-29117)

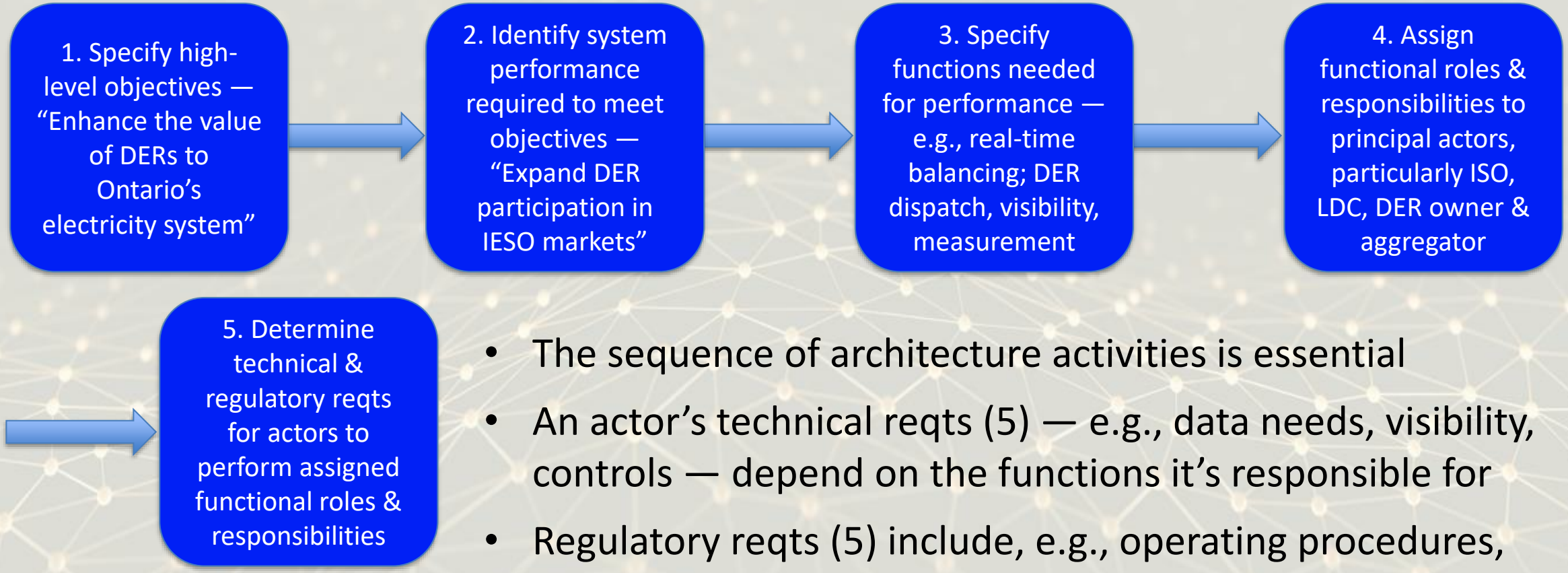
DER-IESO market transactions bypass the distribution system, where electric power must flow for DER/DERA to deliver IESO market services — **even without backflow from D to T**

This **tier bypassing** creates a **coordination gap**

Value stacking adds complexity; e.g., conflicting instructions



Transmission-Distribution Coordination Architecture*



- The sequence of architecture activities is essential
- An actor's technical reqts (5) — e.g., data needs, visibility, controls — depend on the functions it's responsible for
- Regulatory reqts (5) include, e.g., operating procedures, revenue models, contract structures, rates for services, incentive structures

* See "Development of a Transmission-Distribution Interoperability Framework," prepared by ICF for IESO, May 2020

Required Power System Functions (Step 3)

General Functions

System-related: Real-time balancing; frequency regulation; congestion management; resource & transmission scheduling; spot market operation & settlement; contingency dispatch; monitor distribution grid conditions and take needed actions; T&D system infrastructure planning; manage new resource interconnections

Customer-related: Retail electricity supply; metering & billing; interconnection of new load; approval of behind-the-meter DER connections

How have these functions been defined and assigned in the traditional power system? How do they need to be updated for high DER & DER participation in IESO markets?

T-D Coordination Functions (not exhaustive)

Monitor DER operational status and performance; communicate changes in DER/DERA capability as needed; direct DER/DERA to modify behavior if needed for distribution reliability; dispatch DER/DERA for distribution grid services

Architectural Possibilities (Step 4)

T-D Coordination Architecture should meet these objectives

IESO objective: DER provision of IESO market services is dependable, predictable (in operational time) and accurately measurable (for market settlement)

LDC objective: (primary) DER/DERA are able to participate fully in IESO markets with no adverse impacts on distribution system operation; (optional) DER/DERA also provide distribution grid services

DER owner/aggregator objective: DERs earn a dependable revenue stream that fully values services they are technically capable of providing

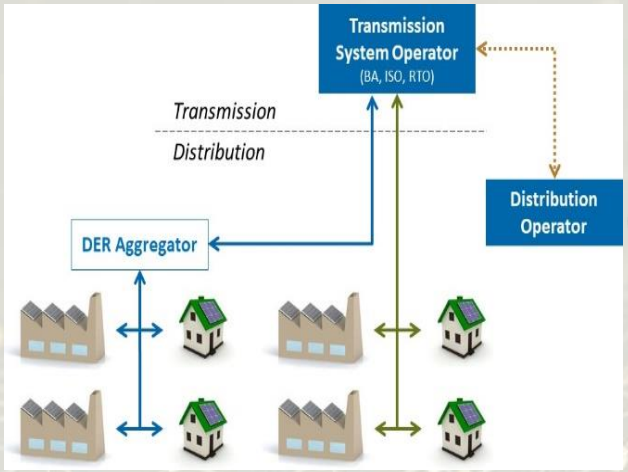
A foundational architectural consideration is the degree of centralization vs layering of functional roles & responsibilities

Total TSO => The IESO models distribution circuits, sees DERs at actual locations, monitors distribution conditions & manages DER impacts on distribution

Total DSO => The DSO (LDC) coordinates all DER/DERA market activity & presents as a single hybrid resource to IESO at each T-D Interface; eliminates tier bypassing

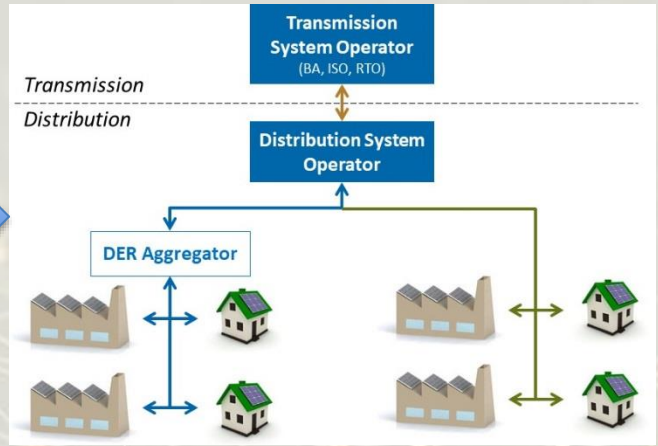
Consider possible T-D Coordination Frameworks along a spectrum between fully centralized & fully layered

❖ **Total TSO**

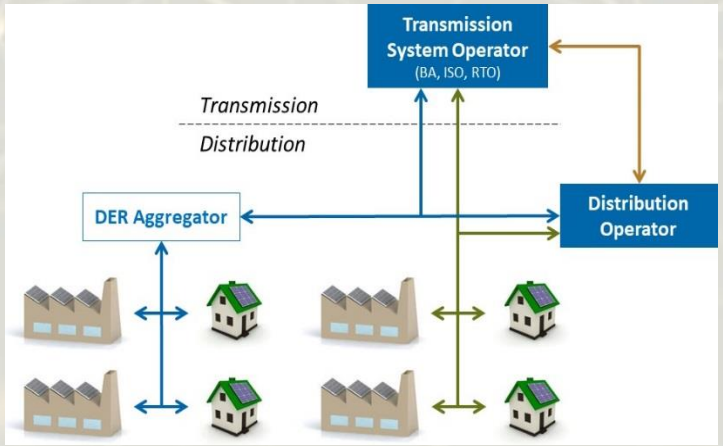


Centralized ⟷ **Layered**

❖ **Total DSO**



❖ **Hybrid DSO**
- coordinated DER dispatch



Hybrid DSO

- ISO dispatches DER/DERA in the wholesale market
- models DER at T-D interfaces
- does not model & has little or no visibility into D system

Hybrid DSO

- LDC dispatches DER for distribution grid services
- coordinates with DER/Aggregator to manage distribution grid impacts

A Brief Survey of Other Regions — US

1. FERC Order 2222 and the US ISOs/RTOs

- 2222 explicitly requires direct participation by DERA in ISO/RTO markets
  - Major responsibilities on Aggregators: telemetry, metering & settlement at DERA level; conveyance of ISO dispatches to DERs; prompt reporting of reduced DERA capacity
  - Provides 60-day period for DSO to review proposed DERA for distribution impacts
  - Provides for DSO to implement "transparent non-discriminatory procedures" to over-ride ISO dispatch instructions
  - ISO will apply non-performance penalties to DERA even if due to distribution issue; FERC declined to assign liability to DSO for distribution-related DERA curtailments
  - Allows for DSO to assess wholesale market "participation charge" to Aggregators to recover DSO's implementation costs
  - Allows for "heterogeneous" DERA that include both non-injecting DER (DR resources) and injecting DER
- All US ISOs/RTOs are pursuing a more centralized hybrid model
  - CAISO has had DERA participation model since 2016 and nobody uses it (prefer DR)

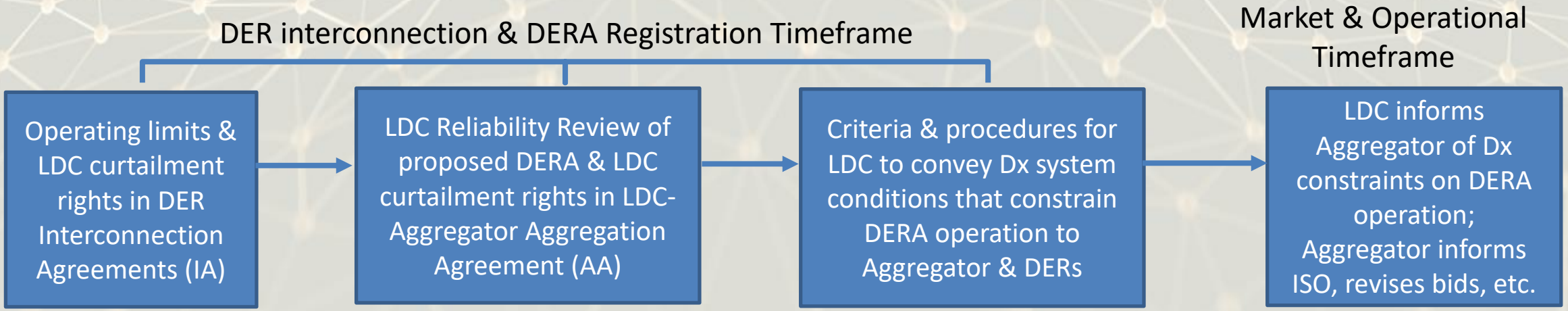
A Brief Survey of Other Regions — US

Major T-D coordination issues with FERC Order 2222

- How to communicate & manage distribution conditions, planned & unplanned circuit outages, that affect DERA capacity to perform
- Details of studies & criteria for LDC 60-day review of proposed DERA; ISO criteria for accepting LDC finding of significant operational risk
- Details of procedure for LDC over-ride of ISO dispatch of a DERA

Coordination architecture being explored by some US LDCs for 2222 compliance

Strategy: Mitigate DER/DERA distribution impacts in advance through interconnection limits & aggregation agreement, to eliminate need for real-time LDC review of ISO dispatches



A Brief Survey of Other Regions — UK & Australia

2. UK Open Networks Project

- Driven by government mandates for decarbonization, digitization, decentralization
- Goal to maximize system flexibility from DERs to manage peak loads & constraints
- Defined 8 key DSO functions, including management of DER impacts on distribution, and distribution constraint impacts on DERs
- Project ongoing, implementing least-regrets DSO-ISO coordination; DER registry

3. Australia Open Networks Projects

- Driven by grid instability concern due to massive rooftop solar PV adoption
- Concluded June 2020 with adoption of "Hybrid DSO" model separating distribution market operator (DMO => assign to AEMO (ISO)) and distribution system operator (DSO => assign to DNSP (LDC)) — comparable to Hybrid DSO (slide 11)

Common elements

- LDCs are wires-only companies, separate from retailers, unlike US
- Efforts started with defining required functions, focus on DER-ISO-LDC coordination


Thank you.
Lorenzo Kristov
LKristov91@gmail.com
Electric System Policy, Structure, Market Design