NARUC-NASEO DER INTEGRATION AND COMPENSATION WORKSHOP

September 20-21, 2022

LUNCH: 11:45AM – 12:45PM
WELCOME AND INTRODUCTIONS: 12:45PM – 1:15PM

WIFI: MarriottBonvoy_Guest

WELCOME!

Kirsten Verclas, NASEO
Tanya Paslawski, NARUC
Sarah Fitzpatrick, NARUC

Thank you to the U.S. Department of Energy for supporting this effort.

National Association of State Energy Officials

AGENDA

DAY 1: DER-BULK POWER SYSTEM COORDINATION

1:15PM – 2:15PM: Order 2222 Industry Working Groups' Conclusions and Recommendations, *EPRI, ESIG, & AEE*

2:15PM – 2:30PM: Break

2:30PM – 3:30PM: Input Session: Grid Services, Interfaces, and Possible Compensation Approaches, *Joe Paladino*

3:30PM – 3:45PM: Break

3:45PM – 4:45PM: Input Session: Perspectives on RTO/ISO Support Opportunities in Order 2222 Implementation, *Paul Spitsen*

4:45PM – 5:00PM: Wrap-up & Feedback

National Association of State Energy Officials

AGENDA

DAY 2: DER INTEGRATION THROUGH ADVANCING INTERCONNECTION

9:00AM – 10:10AM: Session 1A: Aligning Policy and Regulation for Interconnection, *NREL*

10:10AM – 10:30AM: Session 1B: U.S. Department of Energy I2X Initiative, *DOE*

10:30AM – 11:00AM: Break

11:00AM – 12:00PM: Session 2A: Effective Practices in Hosting Capacity Analysis, *DOE*

12:00PM – 1:00PM: Lunch

National Association of State Energy Officials

AGENDA

DAY 2: DER INTEGRATION THROUGH ADVANCING INTERCONNECTION

1:00PM – 2:00PM: Session 2B: Screening Criteria Options, *DOE*

2:00PM – 3:00PM: Session 2C: 1547-2018 Adoption Decisions, *NREL*

3:00PM – 3:20PM: Break

3:20PM – 5:00PM: Session 3: State Action Planning, *NARUC & NASEO*

5:00PM: Wrap-up & Feedback

National Association of State Energy Officials

Order 2222 Industry Working Groups' Conclusions and Recommendations

Jens Boemer, EPRI

Debbie Lew, ESIG

Jeff Dennis, AEE

National Association of State Energy Officials

https://naruc.org/cpi-1/deric/

O2222 Phase 1 Project

Collaborative Forum, Gap Assessment, and Implementation Roadmap

Final Report with a Focus on the Transmission Operations and Planning Workstream

Jens Boemer & Erik Ela

NARUC-NASEO Distributed Energy Resources Integration & Compensation Initiative Workshop

Washington, DC
September 20, 2022 Classification: **public**

Looking Back: NARUC and NASEO Briefing Webcast, June 2, 2022

Past Agenda

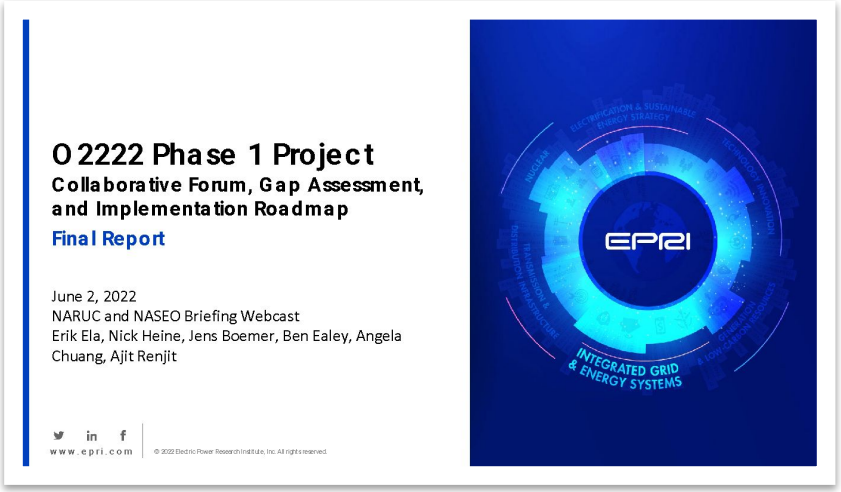
- EPRI FO2222 Project Overview
- Final Report Review
- Q&A, open discussion

Take-Aways

- Maps well to all NARUC/NASEO Initiative tracks
- Grounded in deep EPRI research, yet broad in scope
- Highly collaborative project with various stakeholder groups

Overarching Recommendations

- Coordination, Education, Collaboration
- Terminology Consistency
- Begin granular, work up to collective mitigation strategies
- Prepare for future evolution now
- Harmonization is beneficial when possible



https://www.epri.com/research/products/000000003002020599

Today's Agenda

- EPRI FO2222 Project Overview
- Final Report: Deeper Dive into Transmission Operations and Planning Workstream
  - Focus on Recommendations for NARUC/NASEO members
- Q&A, open discussion

(More Q&A and open discussion on this topic tomorrow with a focus on "DER Integration through Advancing Interconnection")

FO2222 Phase 1 Project

650+ individual participants from 32 companies
4,000+ cumulative attendees

Over 45 unique webcasts

Summary, history and gap assessment

11 workstream guides

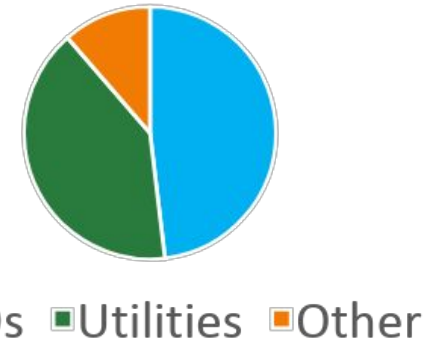
DERA Use Case Survey Tool

Final Implementation Roadmap Report

- Wholesale Market Operations & Design
- Distribution Reliability & Safety
- Transmission Operations & Planning
- Transmission, Distribution & Aggregator Coordination
- Information, Communication, Cyber Security
- Customer Technologies & Retail Programs

Bringing together key stakeholders to ensure the reliable and economic participation of distributed energy resources in wholesale electricity markets and establishing a research and development roadmap

Participation

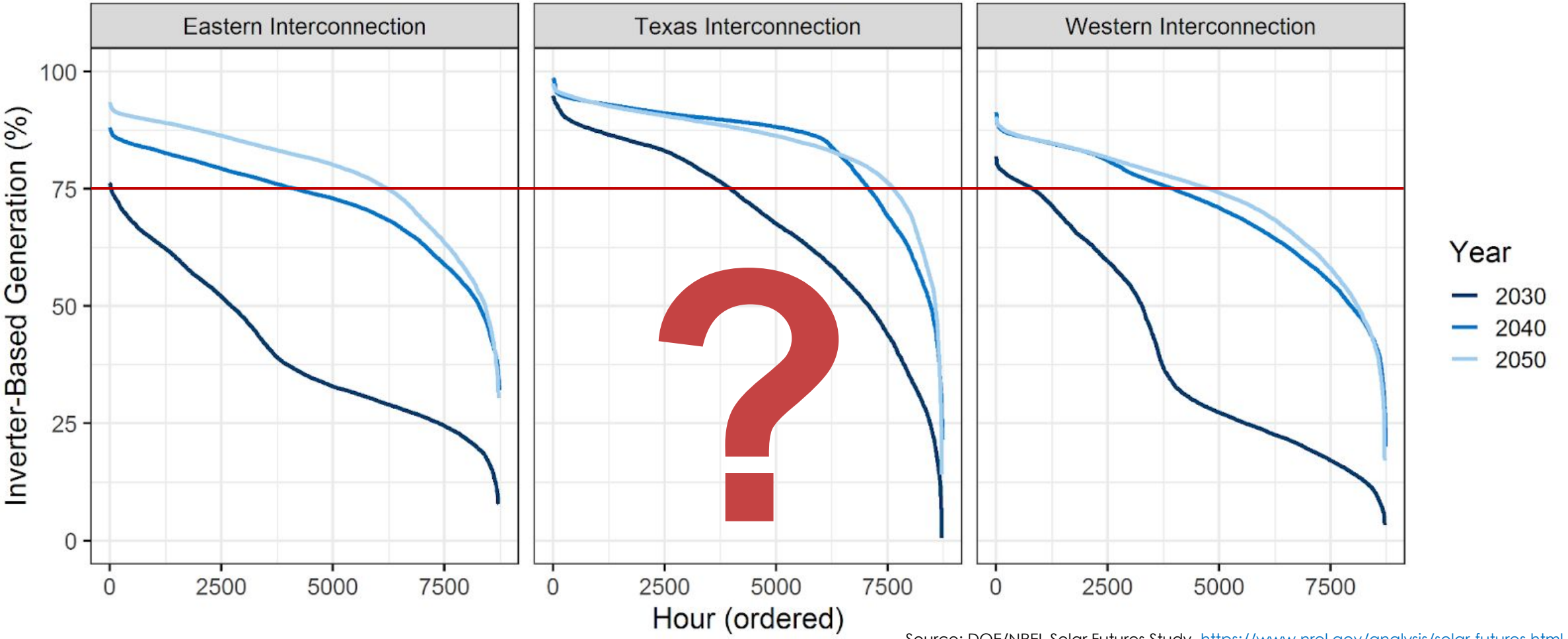


Collaboration opportunities

- Submit RERRA specific perspectives on the DERA MPUC Tool
- Provide any comments on the final report including activities the initiative plans to cover
- Continue engagement and consider shared webcasts across EPRI and NARUC/NASEO members
- EPRI educational sessions with NARUC/NASEO members
- Engage in other forums that would value your perspective (e.g., IEEE ISCT)

Final Project Report: Deeper Dive into Transmission Operations and Planning Workstream

How Plan and Operate a Future Power System with *Uncertain* Instantaneous DER/IBR Penetration?

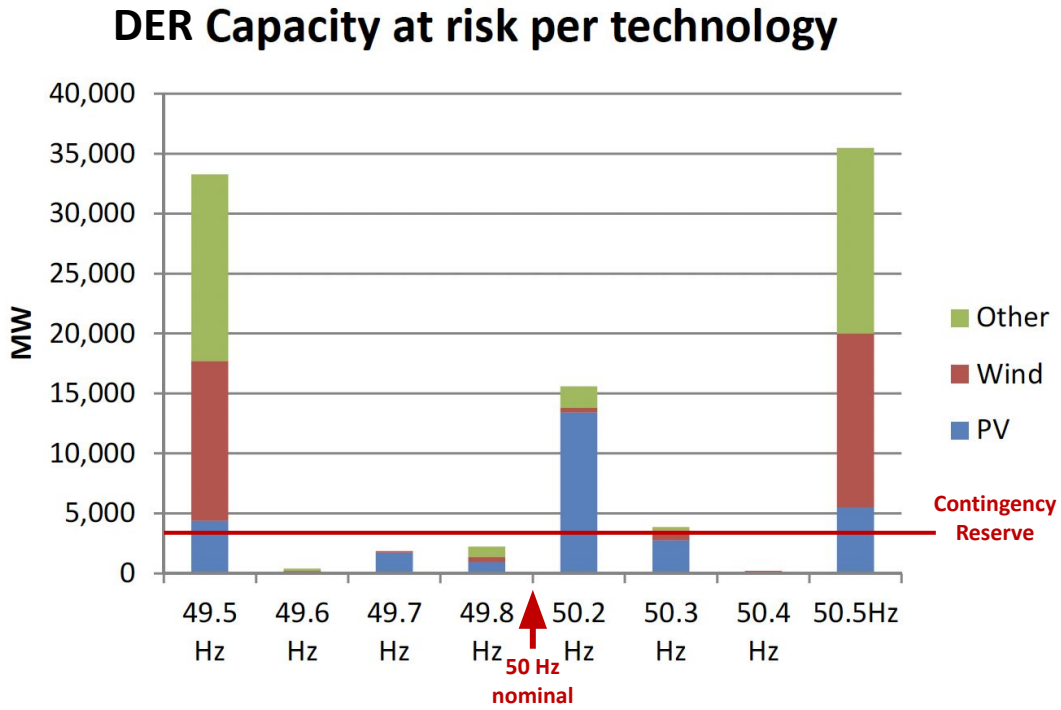


Source: DOE/NREL Solar Futures Study, https://www.nrel.gov/analysis/solar-futures.html

Standardization & Data Collection *Reduces* Uncertainty,
DER Management Systems (DERMS) Integration *Mitigates* Uncertainty

Learning from Europe's "50.2 Hz-Problem"

Problem Definition

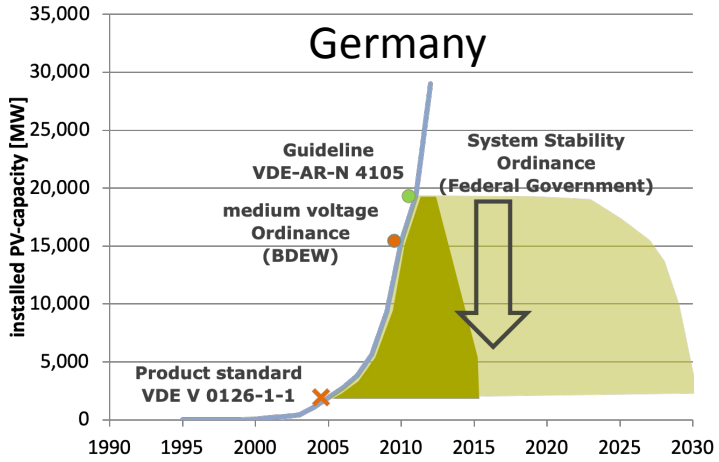


ENTSO-E (2014): Dispersed Generation Impact on CE Region Security. Dynamic Study. 2014 Report Update. [Online]

- ***Significant* bulk system reliability risk.**

Solution

Major **"retrofit" programs** across Europe



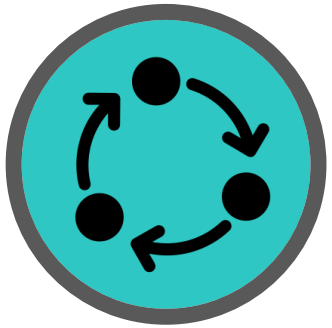
K. Burges/Ecofys (2014): Grid code compliance in a changing environment. *In:* 4th Int. Workshop on Integration of Solar Power into Power Systems. Berlin, Germany, Nov. 10-11.

Lessons Learned

- ***Underestimation of DER deployment** due to different stakeholder mindsets*
- ***Insufficient DER interconnection requirements** due to a lack of stakeholder coordination*
- ***Delayed response** due to lack of DER data collection, modeling, and remote configurability*

Mistakes Are Part of Every Transition Process – Accept Responsibility and Manage Risks

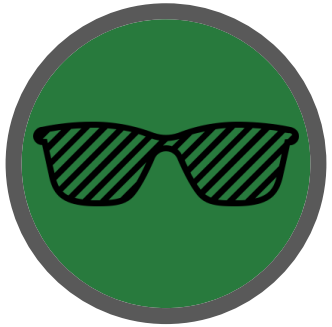
Embrace New Paradigms



"Connect & Manage"

*What may **not** work any more:*

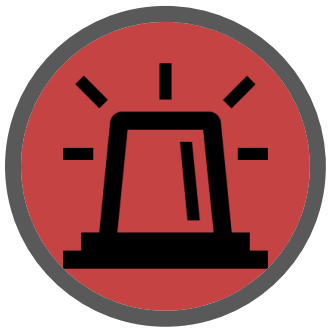
- "Connect and forget"
- Lack of advanced DER *capabilities* (e.g., ride-through)
- Uncoordinated and unverified DER functional *settings*



Advanced DER Data Collection and Modeling

*What may **not** work any more:*

- Lack of centralized databases
- Limited T&D coordination and data exchange
- Modeling DER as net loads



Integration of DER into Grid Operations

*What may **not** work any more:*

- Lack of grid operator communication with DERs
- No ability to (re-)configure DER functional settings remotely

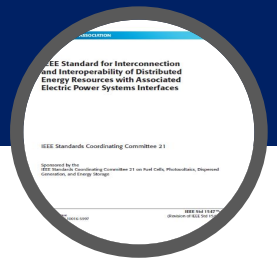
Imagine The Future State, Then *Work Backwards* To Define Near Term Actions

Transmission Operations and Planning

Key **Recommendations** from Workstream 3

WS3
Transmission Operations & Planning

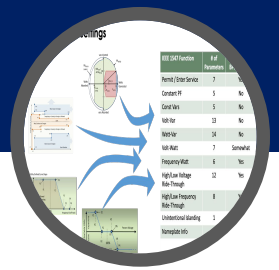
Interconnection Requirements



1

- Adoption of IEEE 1547-2018 with flexibility provided by 1547a-2020
- Require inverters to be certified under UL 1741 SB starting Jan 1, 2023

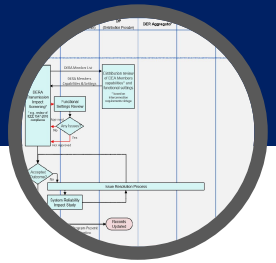
DER Data & Settings



2

- Collection and exchange of DER data across T&D interface
- Coordinate and verify DER functional *settings* that can impact bulk system reliability

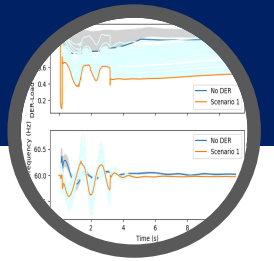
DERA Transmission Impact Screening



3

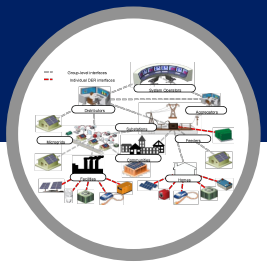
- Conduct Simplified Screening Tests during DERA Transmission Technical Review/ Registration
- Confirm DERA members' functional settings

Modeling & Simulation



- Utilize advanced DER and DERA models and appropriate parameterization
- As needed, use of Aggregate DER (DER_A) model or OEM-provided models, see also: https://www.epri.com/pvmod

DERA Integration into Grid Operations



- Further develop NERC and IEEE models and standards
- Consider registering DER Aggregators as a NERC entity

Looking for participation in IEEE Interconnection Standards Collaboration

Related Resources

Workstream Reports

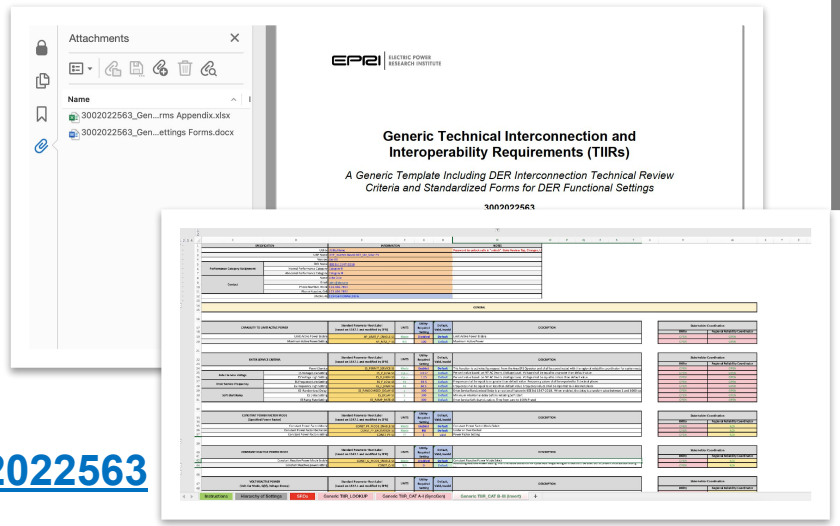
[3002020592]

[3002020591]

NARUC Webinars

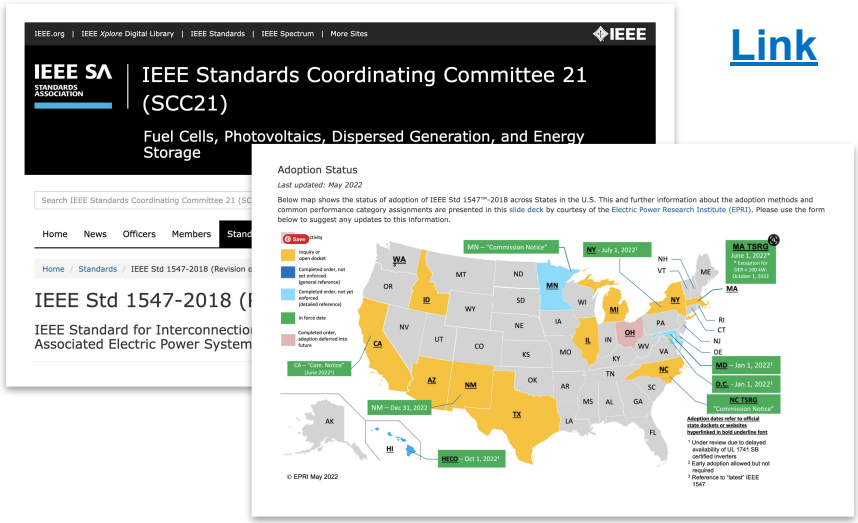
[Link]

TIIR & Settings Templates



[3002022563]

Websites & 1547 Adoption Maps



[Link]

Classification: public

Proposed: IEEE SCC21 Interconnection Standards Collaboration

The ISC is an effort sponsored by SCC21 that facilitates **collaboration across the IEEE Committees** managing interconnection standards development and the entities that reference and apply these standards with the **purpose of coordinating** IEEE SA Standards Project Authorization Requests (PAR) for **existing and new projects**. Targeted standards in scope are the **IEEE 1547 and IEEE 2800** series that specify technical minimum interconnection and interoperability, performance capabilities and functional requirements for generation and storage resources interconnected to distribution grids and bulk power systems, respectively.

Mission Statement

"Providing regulatory decision makers with technical reference standards that can support the timely and reliable transformation of the nation's electricity system."

ISC's activities will focus on:

1) Developing sufficient scope and **consistency** in content across the target standards
2) Coordination and **prioritization** of revisions of target standards, including development of standards revision and application **roadmaps** as well as application and **transition time frames**
3) Support, coordination, and dissemination of **educational materials and resources** that can guide in the timely application of target standards, for example in current or upcoming state PUC/regulatory dockets or initiatives

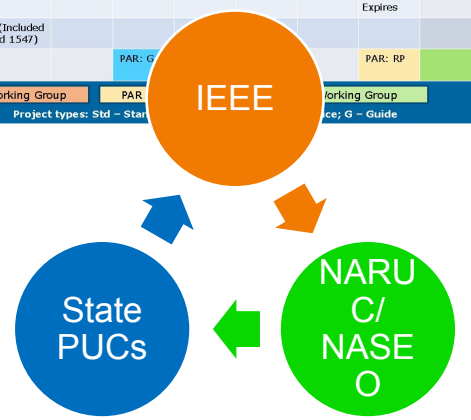
The ISC is open to any stakeholders with subject matter expertise or strategic interest.

IEEE SCC21 Roadmap for P1547.x Standards

Standard	Topic	Expires (10 yrs)	2018	2019	2020	2021	2022	2023	2024	2025	2026
P1547	Base Std	2028	Revised		Amended	PAR: Std		Revision?			
P1547.1	Test Std	2030			Revised		PAR: Std		Revision?		
P1547.2	Application Guide	2018	PAR: G			Expected Revision		PAR: RP		Revision?	
P1547.3	Cyber Security	2018 – parts in 1547-2018		PAR: G			Expected Revision		PAR: RP		Revision?
P1547.4	Intentional Islands	2021				Expires					
P1547.5	DER > 10 MVA	Withdrawn – now partly in P2800									
P1547.6	Secondary Networks	2021 – now in 1547-2018				Expires					
P1547.7	Impact Studies	2023						Expires			
P1547.8	Recommended Practice	Inactive (Included in Revised 1547)									
P1547.9	Storage + V2G	New Std		PAR: G				PAR: RP		Revision?	

Legend: Active Working Group | PAR | …Working Group

Project types: Std – Stan… …ce; G – Guide



IEEE SCC21 Roadmap for P2030.x Standards

	Topic	Expires (10 yrs)	2018	2019	2020	2021	2022	2023	2024	2025	2026
P2030	Base Std	2021			PAR: Guide		Revision				
P2030.1	Guide for EV supply equipment	Inactive				PAR: Guide					
P2030.2	Guide for ES Interoperability	2025					PAR: Guide				
P2030.4	Guide for Control and Automation Syst										
P2030.5	Std Smart Energy Profile		Revision			Revision					
P2030.11	Guide for DERMS				Revision						

KEY: Working Group | PAR Development | Future Working Group

Conclusions

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It's been done before!
The time to walk the path is *now*.

Adopt **minimum DER capability requirements** in forward-looking technical interconnection requirements; improve interconnection processes where needed.

Encourage, initiate, or lead regional **transmission & distribution coordination** forums. Engage in **new IEEE SC21 Interconnection Standards Collaboration.**

Questions & Comments

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BACKUP

Transmission Operations and Planning

Key **Findings** from Workstream 3

WS3
Transmission Operations & Planning

Interconnection

- Legacy DER may lack *capabilities* or not perform to support bulk system reliability
- Leading state PUCs not require DERs to have IEEE 1547-2018 capability / inverters to be certified under UL 1741 SB until Jan 1, 2023

Visibility & Configuration

- Lack of DER data collection and centralized databases
- Limited T&D coordination and data exchange
- Uncoordinated and unverified DER functional *settings*

Modeling & Analysis

- DERs often still modeled as net loads
- Aggregate DER (DER_A) model not commonly used

EPRI (2019): 3002015320

Operations & Control

- Lack of grid operator communication with DERs
- No ability to (re-)configure DER functional settings remotely
- Firm interconnection capacity

Standards

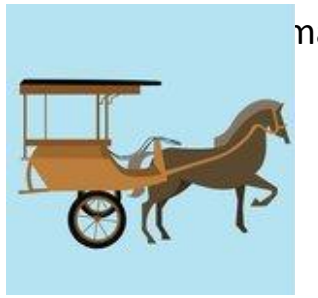
- NERC functional model and IEEE smart grids interoperability reference model
- DER Aggregator not a NERC registered entity
- Potential gaps in NERC reliability standards

Capability versus Utilization

Capability:

"Ability to Perform"

- Functions
- Ranges of available settings
- mance specifications



Examples

- Frequency Response
  - Frequency Droop Response
  - Ramp rate limitations
- Ride-Through
  - Voltage ride-through
  - Current injection during ride-through
  - Consecutive voltage ride-through
  - Frequency ride-through
  - ROCOF ride-through
  - Phase angle jump ride-through

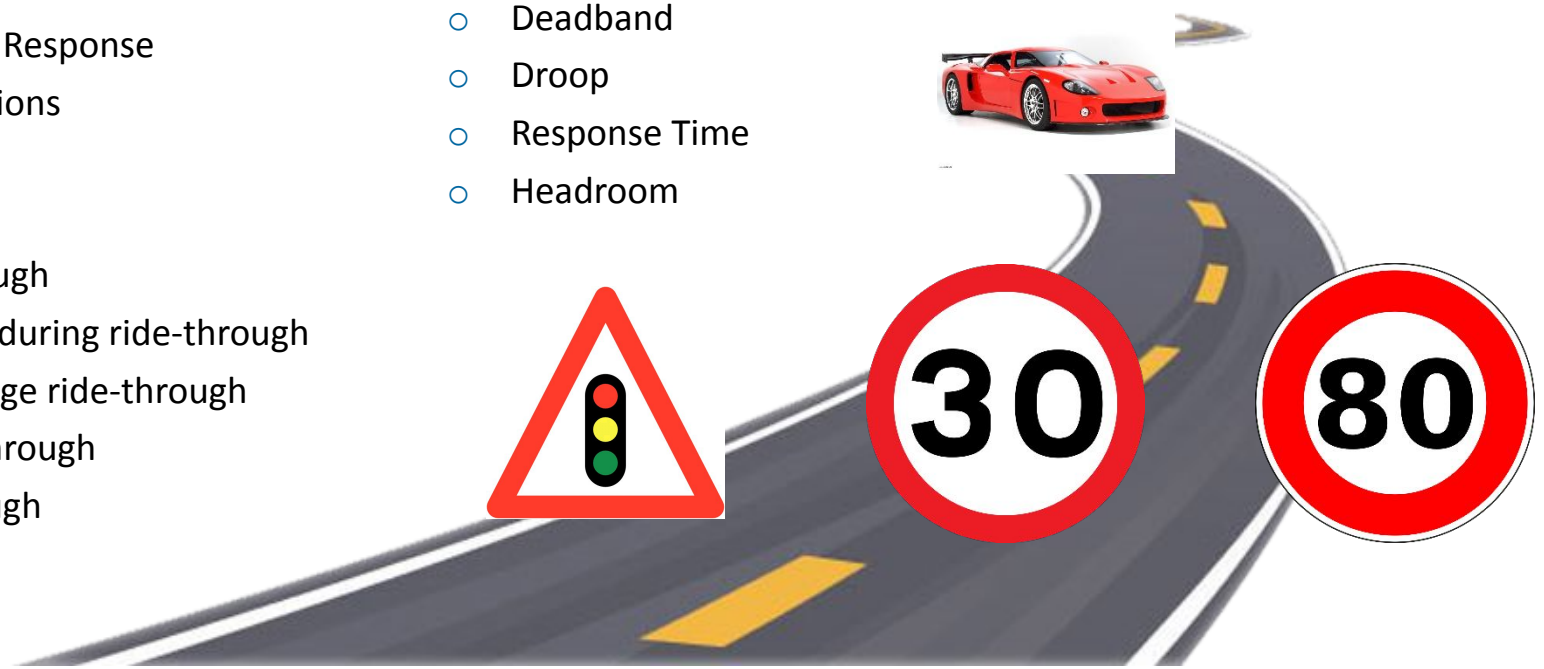
Utilization of Capability:

"Delivery of Performance"

- Enable/disable functions
- Functional settings / configured parameters
- Operate accordingly (e.g., maintain headroom, if applicable)

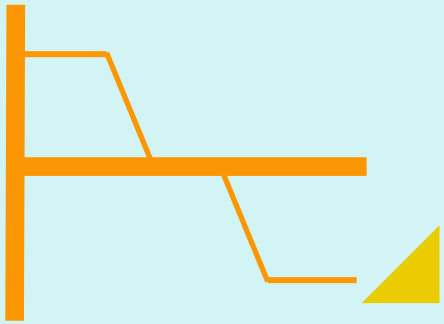
Examples

- Deadband
- Droop
- Response Time
- Headroom



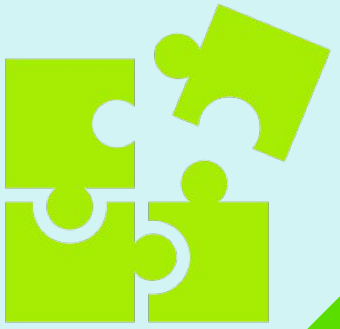
Steps to Unlock Benefits of Advanced DER

Grid Planning & Technical Interconnection Requirements
(e.g., IEEE 1547-2018)



Specify **DER** Performance and Functional **Capabilities**

- e.g., adopt IEEE Std 1547-2018



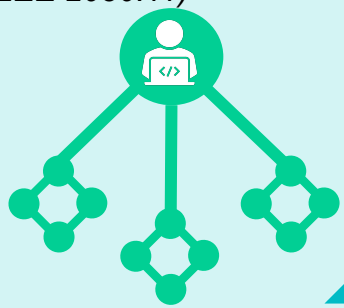
Update interconnection agreements

- e.g., allow for **utilization** of DER capabilities

Research, Development, Standardization
(e.g., DERMS, IEEE 2030.11)

Design architecture and deploy DER **communication infrastructure**

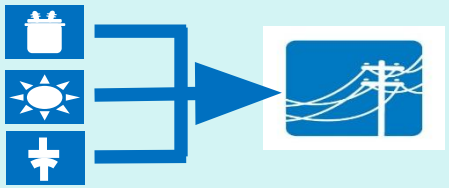
- e.g., start with utility-scale DER before integrating retail-scale DER



Specify DER Management System and select **DER Aggregations/ Group Management** Functions

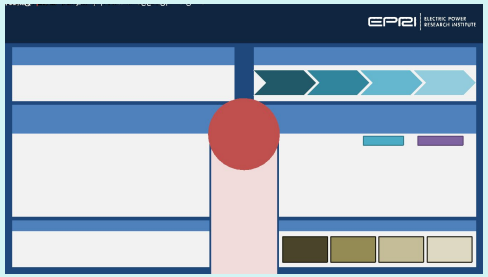
- e.g., codify messages to be exchanged across the T&D interface

Markets & Operations
(e.g. FERC Order 2222)



Design **market** and integrate DER into **grid operations**

- e.g., energy products, capacity products, re-dispatch, regulating reserves



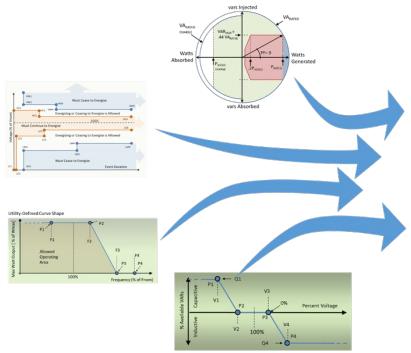
**FERC Order 2222 Phase 1: Collaborative Forum, Gap Assessment, and Implementation Roadmap, https://www.epri.com/research/products/000000003002020167*

Example 1: DER Performance Diversity

Problem Definition

- Lack of harmonized requirements for advanced DER capabilities, performance, and interoperability
- DER functional settings and performance ("vintage") can impact bulk system performance
- Retrofit of DER capabilities and re-configuration of functional settings is challenging and undesired

DER Functional Settings



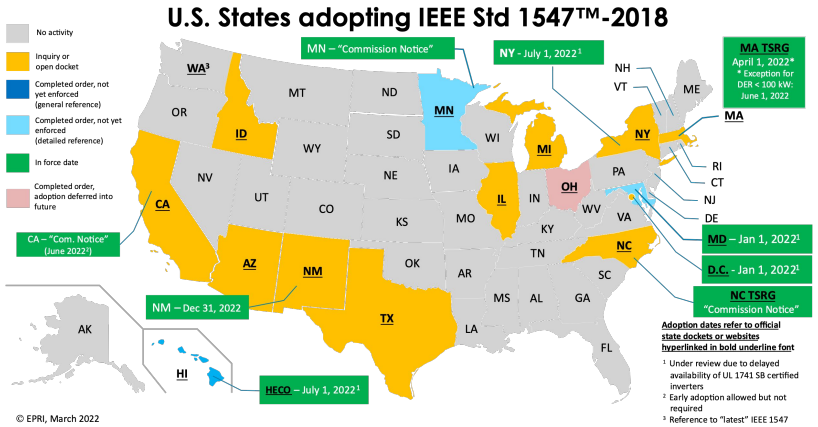
IEEE 1547 Function	# of Parameters	Relevance for BPS reliability
Permit / Enter Service	7	Yes
Constant PF	5	No
Const Vars	5	No
Volt-Var	13	No
Watt-Var	14	No
Volt-Watt	7	Somewhat
Frequency-Watt	6	Yes
High/Low Voltage Ride-Through	12	Yes
High/Low Frequency Ride-Through	8	Yes
Unintentional Islanding	1	No
Nameplate Info	21	Yes
Total	**99**	

EPRI (2020) 3002020201 | EPRI (2022): 3002020592

- ***Uncertain* existing and future DER performance**

Potential Solution

Use industry standards for technical minimum performance requirements and DER communication capabilities, e.g.:



See also: https://sagroups.ieee.org/scc21/standards/1547rev/

Lessons Learned

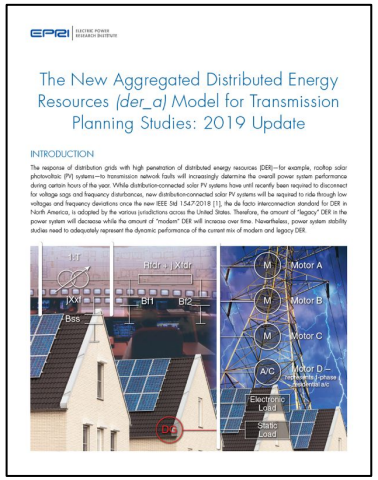
- *IEEE standards revision and UL certification for smart inverters can take years*
- *Increased standards revision cycles allow for incremental DER improvements that are easier to bring to market*

Work With Regional Stakeholders on Revision of DER Interconnection Requirements

Example 2: DER Planning Case Studies

Problem Definition

- Uncertain future DER deployment
- DERs insufficiently modeled in transmission planning studies, despite available models and guidelines:



EPRI (2019): 3002015320

Table 2.1: Default DER_A Model Parameters

Param	IEEE Std. 1547-2003 Default	IEEE Std. 1547a-2014 Default	CA Rule 21 Default	IEEE Std. 1547-2018 Category II Default	Notes
trv	0.02	0.02	0.02	0.02	† Note 1
dbd1	-99	-99	-99	-99	† Note 1
dbd2	99	99	99	99	† Note 1
kqv	0	0	0	0	† Note 1
vref0	0	0	0	0	† Note 2
tp	0.02	0.02	0.02	0.02	†
tiq	0.02	0.02	0.02	0.02	†
ddn	0	0	20	20	Note 3
dup	0	0	20	20	Note 3
fdbd1	-99	-99	-0.0006	-0.0006	Note 3
fdbd2	99	99	0.0006	0.0006	Note 3
femax	0	0	99	99	Note 3
femin	0	0	-99	-99	Note 3
pmax	1	1	1	1	† Note 4
pmin	0	0	0	0	Note 4
dpmax	99	99	99	99	†
dpmn	-99	-99	-99	-99	†
tpord	0.02	0.02	5	5	Note 3
imax	1.2	1.2	1.2	1.2	† Note 4
vll	0.44	0.44	0.49	0.44	Note 5
vl1	0.44×V_{SHAPE}	0.44×V_{SHAPE}	0.49×V_{SHAPE}	0.44×V_{SHAPE}	Note 5
vh0	1.2	1.2	1.2	1.2	Note 5
vh1	1.2×V_{SHAPE}	1.2×V_{SHAPE}	1.2×V_{SHAPE}	1.2×V_{SHAPE}	Note 5
tvl0	0.16	0.16	1.5	0.16	Note 5
tvl1	0.16	0.16	1.5	0.16	Note 5
tvh0	0.16	0.16	0.16	0.16	Note 5
tvh1	0.16	0.16	0.16	0.16	Note 5
vfrac	0	0	1	1	Note 5
flrz	59.3	59.5 OR 57.0	58.5 OR 56.5	58.5 OR 56.5	Note 6
fhrz	60.5	60.5 OR 62.0	61.2 OR 62.0	61.2 OR 62.0	Note 6
tfl	0.16	2.0 OR 0.16	300.0 OR 0.16	300.0 OR 0.16	Note 6
tfh	0.16	2.0 OR 0.16	300.0 OR 0.16	300.0 OR 0.16	Note 6
tg	0.02	0.02	0.02	0.02	†
rrpwr	0.1	0.1	2.0	2.0	Note 8
tv	0.02	0.02	0.02	0.02	†
Kpg	0	0	0.1	0.1	Note 3
Ksg	0	0	10	10	Note 3
xe	0.25	0.25	0.25	0.25	† Note 8
vzr	0.8	0.8	0.3	0.3	Note 6
iqh1	0	0	1	1	Note 1
iql1	0	0	-1	-1	Note 1
pflag	1	1	1	1	† Note 7
frqflag	0	0	1	1	Note 7
qflag	P priority	P priority	Q priority	Q priority	Note 7
typeflag	1	1	0 OR 1	0 OR 1	Note 7

NERC (2020): Online

- ***Unknown* bulk system reliability risk**

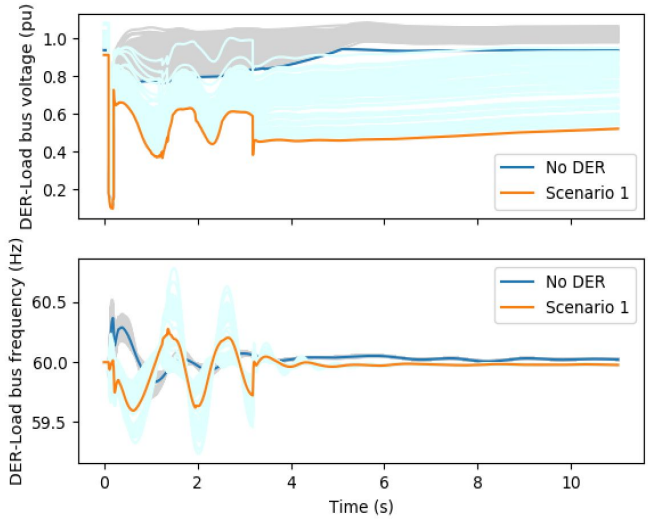
Potential Solution

Bulk system **stability studies** with DER

- DER scenarios up to "transmission hosting capacity"
- DER_A performance and settings sensitivity analysis

Lessons Learned

- *DER performance like **IEEE 1547-2018 improves stability***

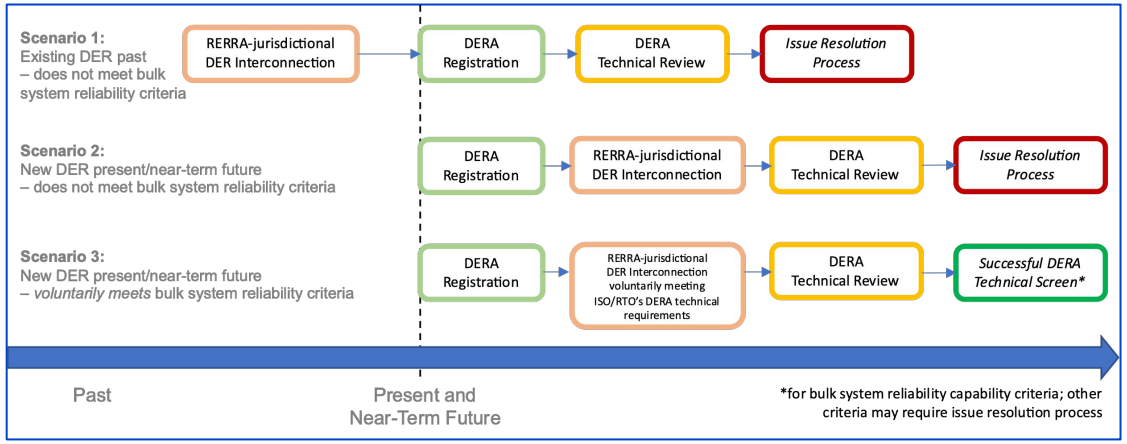


EPRI (2020): 3002019437
EPRI (2021): 3002019444

Utilize Data and Models To Determine Desirable Future DER Performance

Example 3: FERC O2222 DER Aggregations Transmission Impact Assessment

Problem Definition



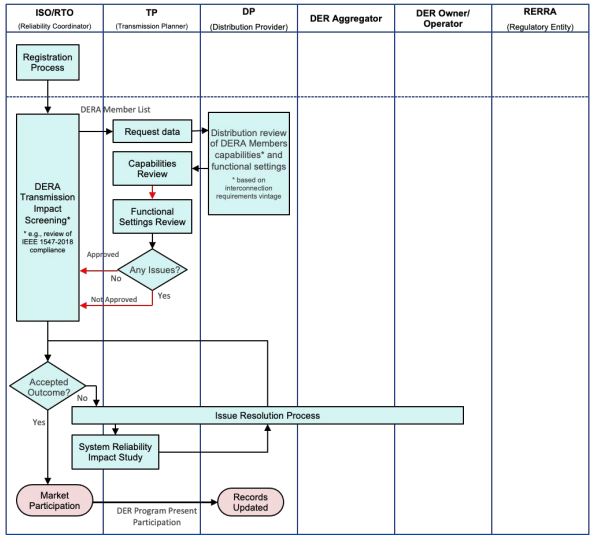
EPRI (2022): 3002020592

- Distribution DER interconnection requirements may not yet include bulk system reliability criteria
- Transmission impact assessment under state PUC's interconnection process is limited to utility-scale DER
- **Need for simple procedures that avoid duplication of steps from state jurisdictional interconnection process**

Potential Solution

DERA **Transmission Impact *Screening*** based on review of DERA members data:

- not located across congested bulk system regions
- conformance with IEEE 1547-2018 / UL 1741 SB
- reliable functional settings
- metrics do not indicate "weak grid" issues, etc.



EPRI (2022): 3002020592

Lessons learned

- *Further research needed to substantiate adequacy of screens*

Reduce Operational Risks By Addressing DERA Transmission Impacts In Planning

Example 4: DER Management Systems

Problem Definition

- Lack of low-cost DER communication networks deployment
- No ability to (re-)configure DER functional settings remotely
- Lack of ability for coordinated DER active power dispatch and management

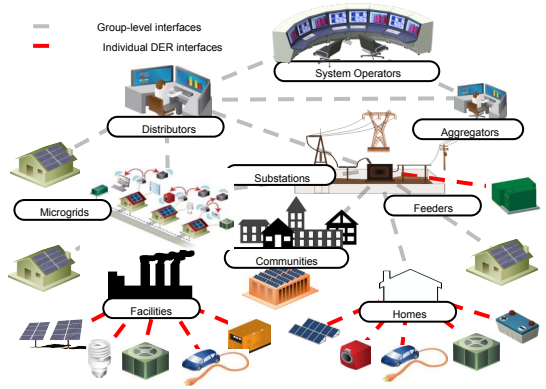
- Increased focus on participation of DER aggregations in wholesale markets due to FERC Order 2222

- ***Unreliable* bulk system operation**

Potential Solution

DER Management Systems perform **four key functions**:

- Aggregate | Simplify
- Optimize | Translate



EPRI (2022): 3002021985

EPRI TSO-DSO Coordination WG

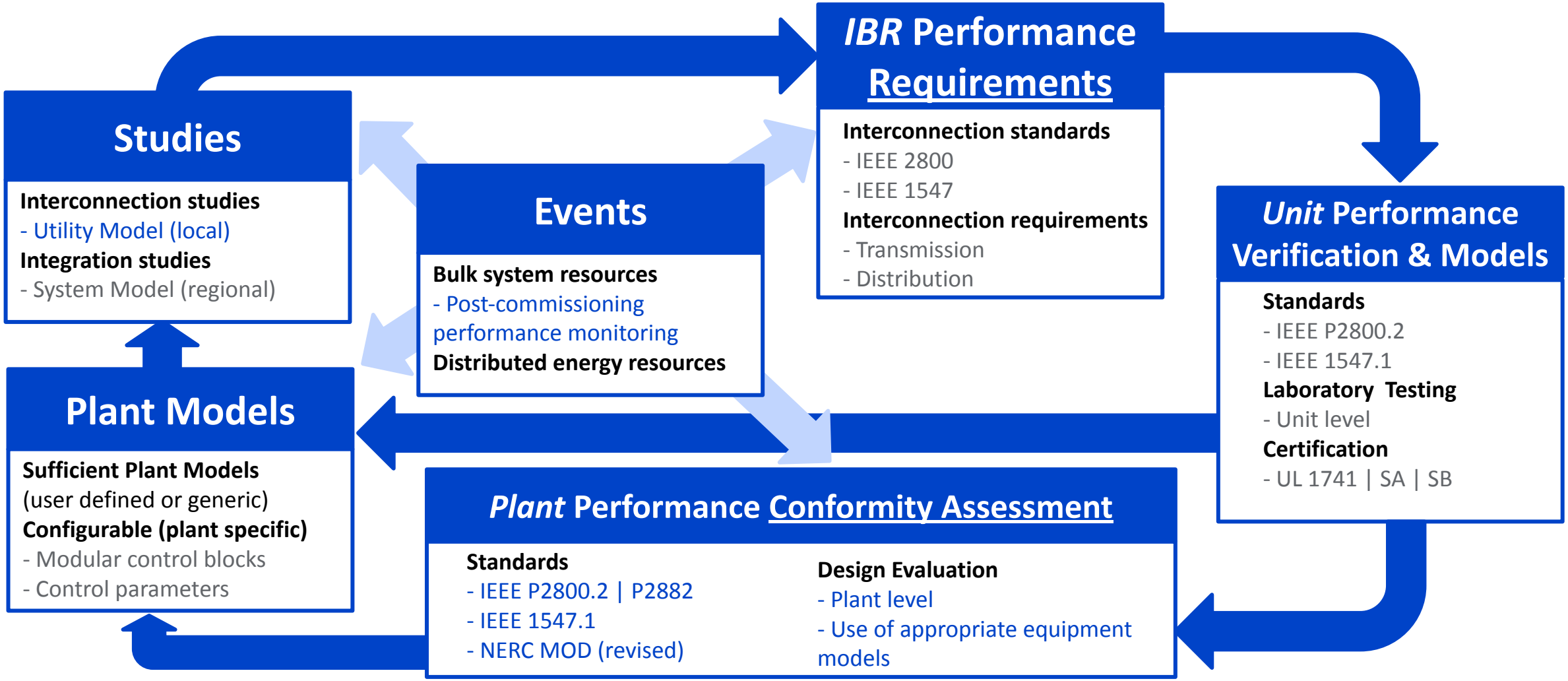
- Developed a menu of standard T&D coordination functions and data sets that inform EMS, MMS, DMS, DERMS, CIS, SCADA, etc.

Lessons Learned

- *Harmonization is beneficial when possible*

Integration of DERs Provide Flexibilities To Mitigate Uncertainty

Outlook: Continuous and Iterative Improvement of DER/IBR Performance Requirements, Plant-Level Modeling, and Model Validation

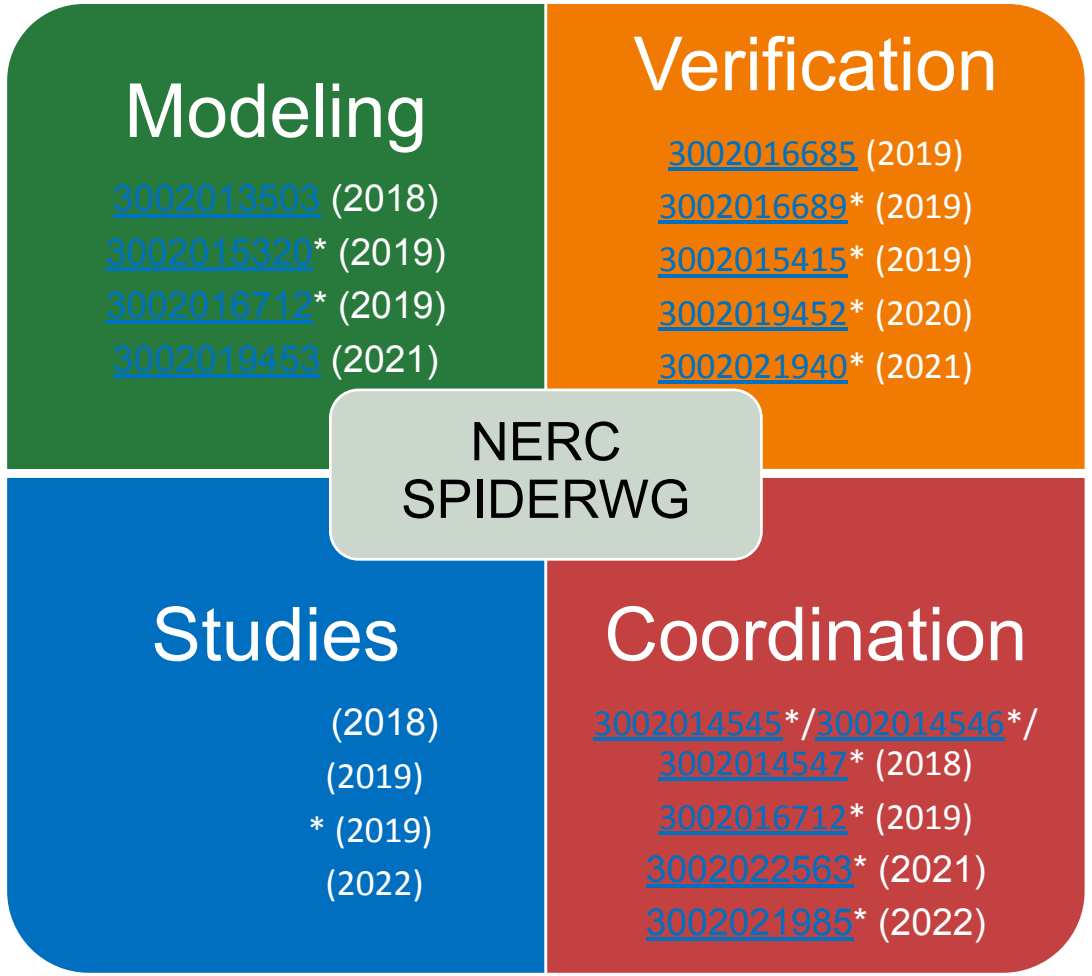


Engage in Relevant Industry Working Groups

EPRI Research Related to NERC SPIDER Working Group

- DER Modeling Survey
- DER_A Parameterization Guideline
- DER Data Collection Guideline
- MOD-032-1 Review/SAR
- Modeling Notification
- BESS and Multiple DER

- Guideline on BPS Planning Practices with DER
- White Paper: TPL-001 Standard Review
- Recommended Simulation Improvements (with RSTC)
- Guidance on UFLS
- White Paper: Beyond Positive Sequence



Product IDs indicate related EPRI research.
* Publicly available deliverables

- DER Verification Guideline
- DER Forecasting Practices Guideline

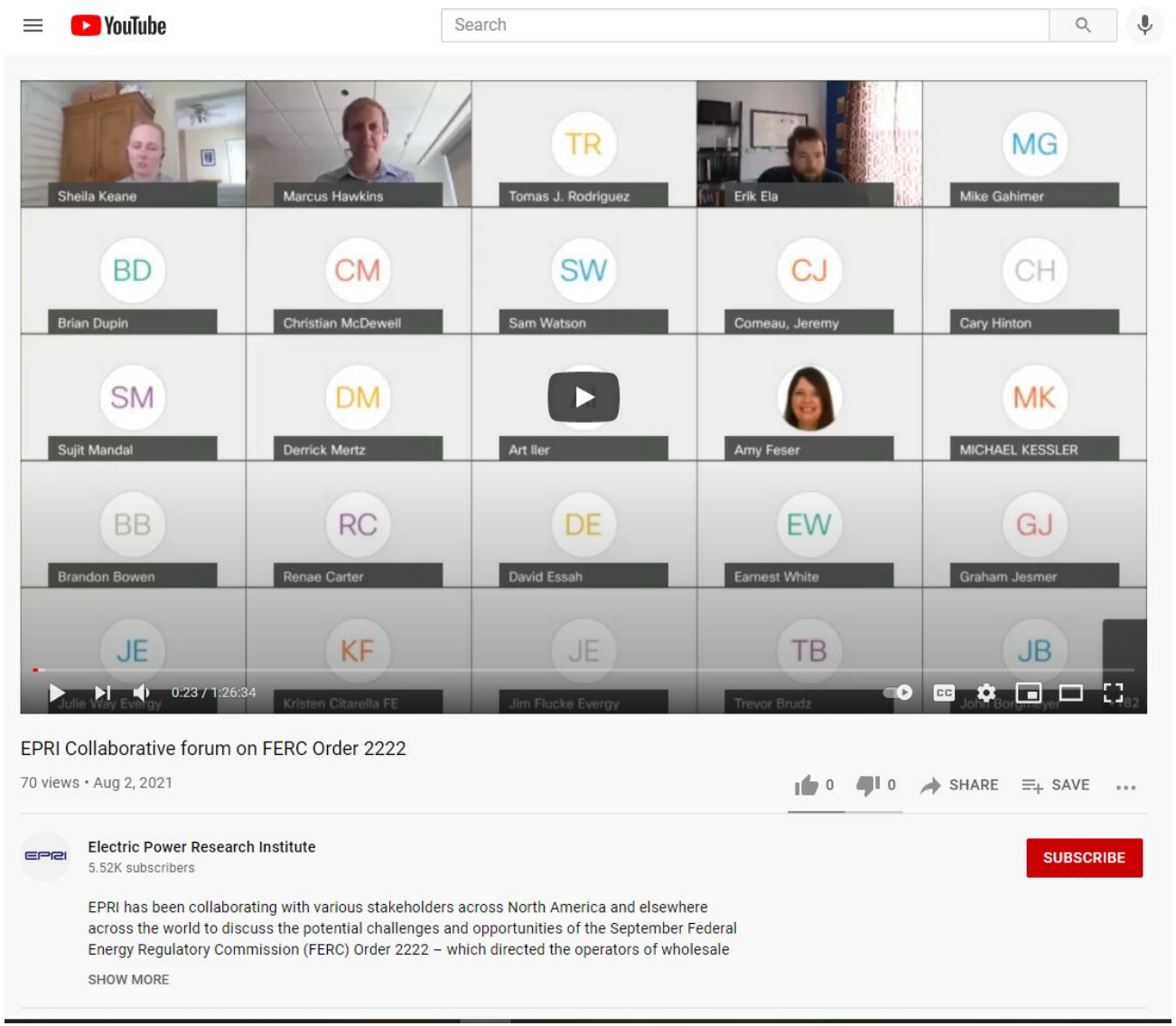
- IEEE Std. 1547-2018 Review and BPS Recommendations
- Guideline on Communicating across T-D Interface
- Coordination of Terminology
- NERC Standards Review
- Tracking DER Growth
- BPS Reliability Perspectives for DER Aggregator

Published
Public Consultation
Draft available

EPRI FO2222 Project Overview

Large collaboration across ISOs/utilities and integrating multiple EPRI research areas

RERRA Session

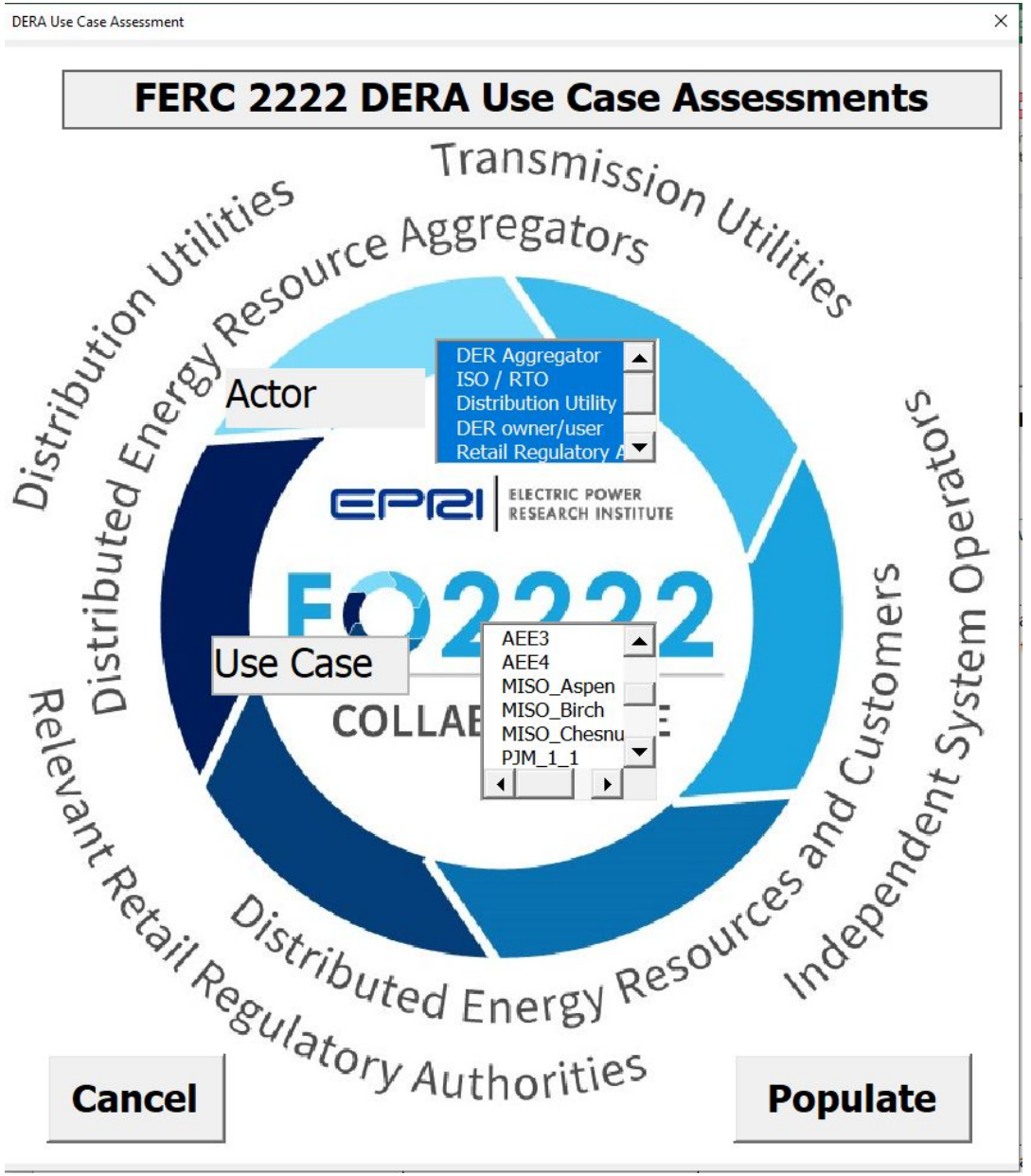


- Panel session with state regulators (Senior Staff to Chairperson) from states within each ISO/RTO
- Key challenges and opportunities
- Q&A from RTOs and utilities

[EPRI Collaborative forum on FERC Order 2222 - YouTube]

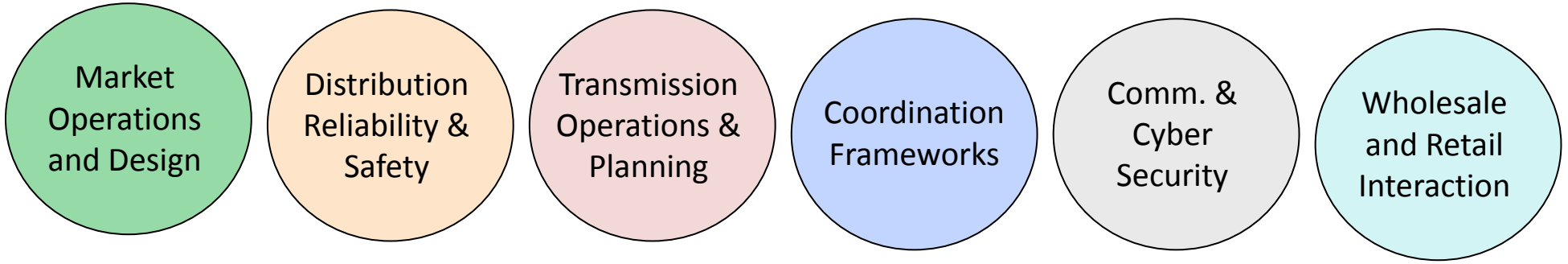
DERA Use Case Survey Tool

- Requested by ISO RTO Council
- Many different types of DER Aggregations
  - Difficulty in understanding what the challenges are
- Defined by technologies, locations, services, and retail participation
- Shared broadly with key stakeholders
- Updated regularly with populated information

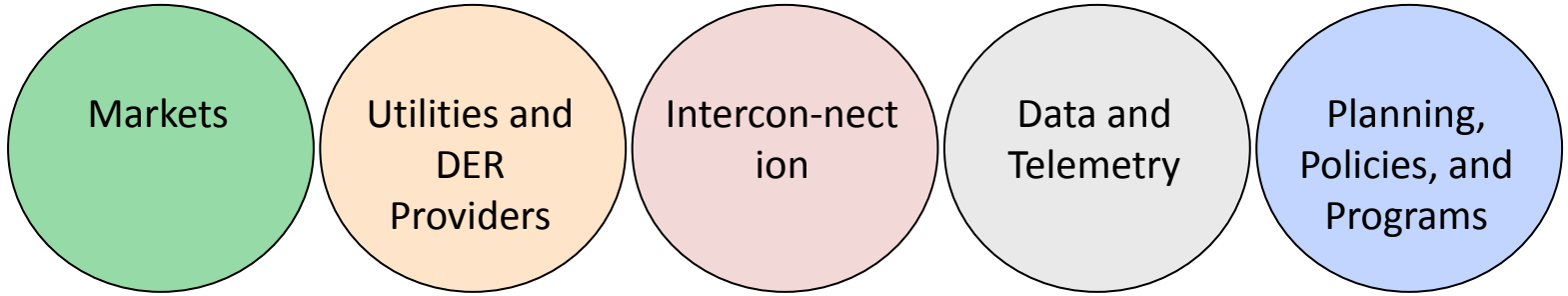


Alignment of Initiatives

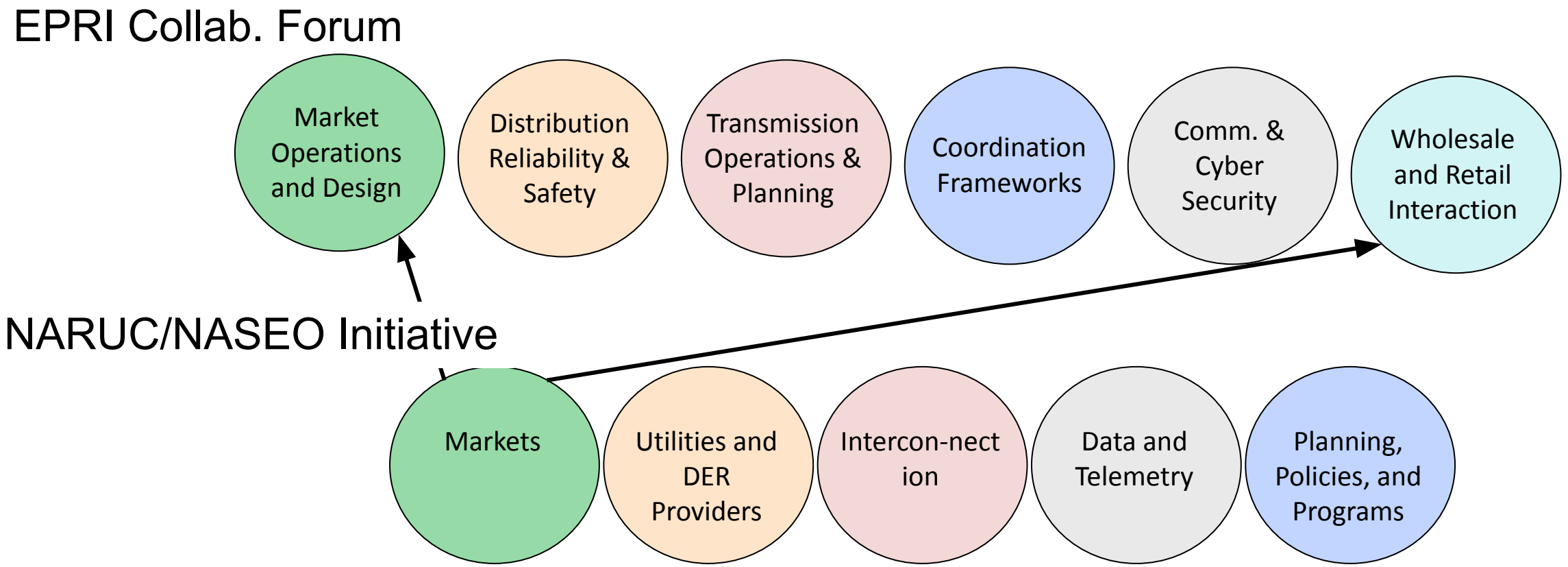
EPRI Collab. Forum



NARUC/NASEO Initiative

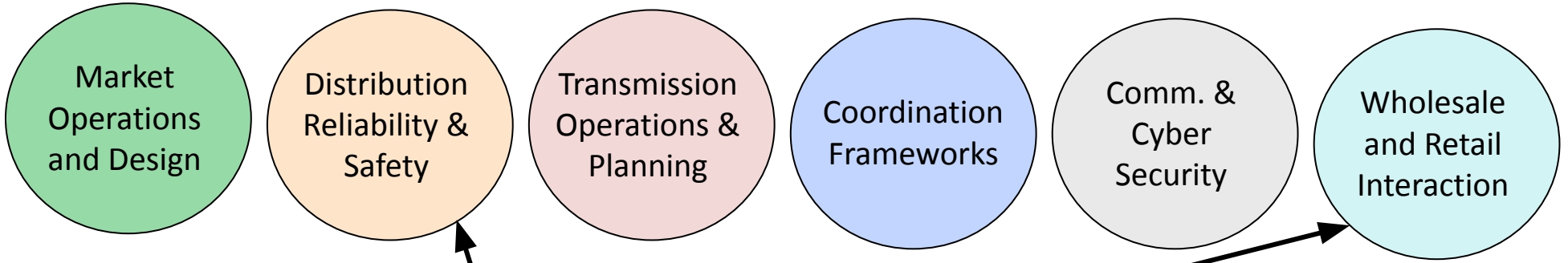


Alignment of Initiatives



Alignment of Initiatives

EPRI Collab. Forum



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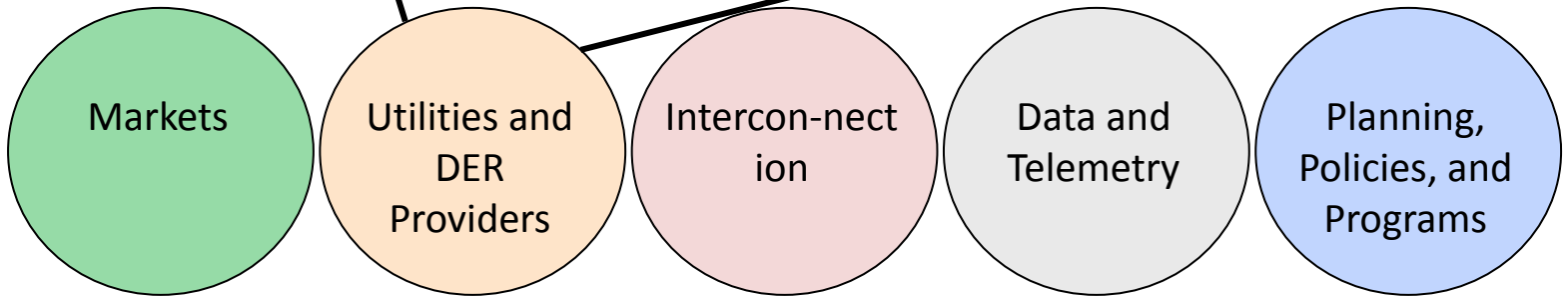

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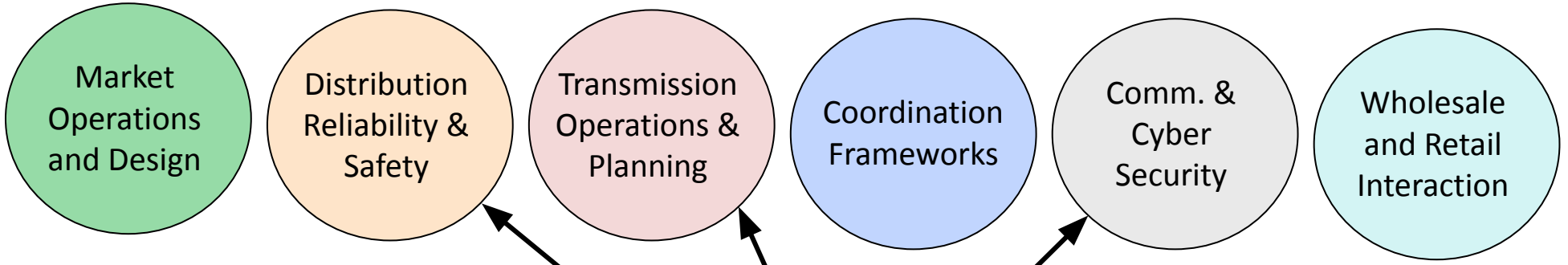

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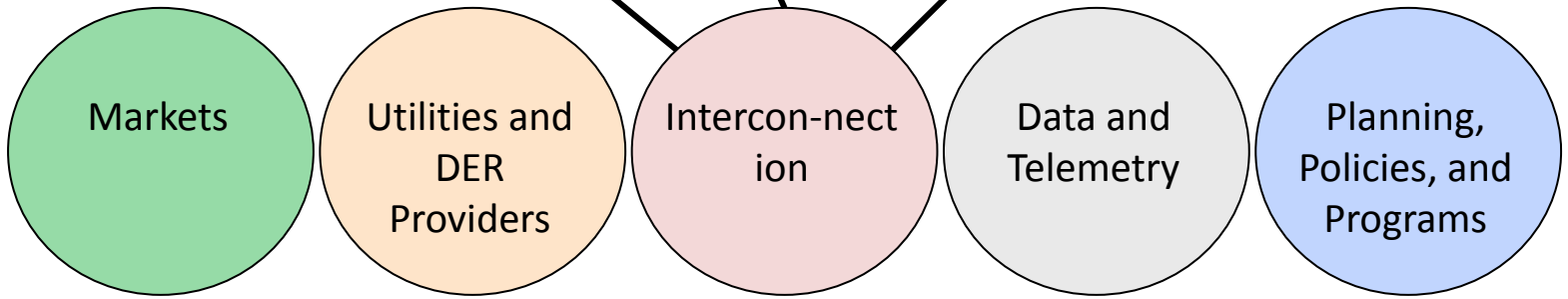

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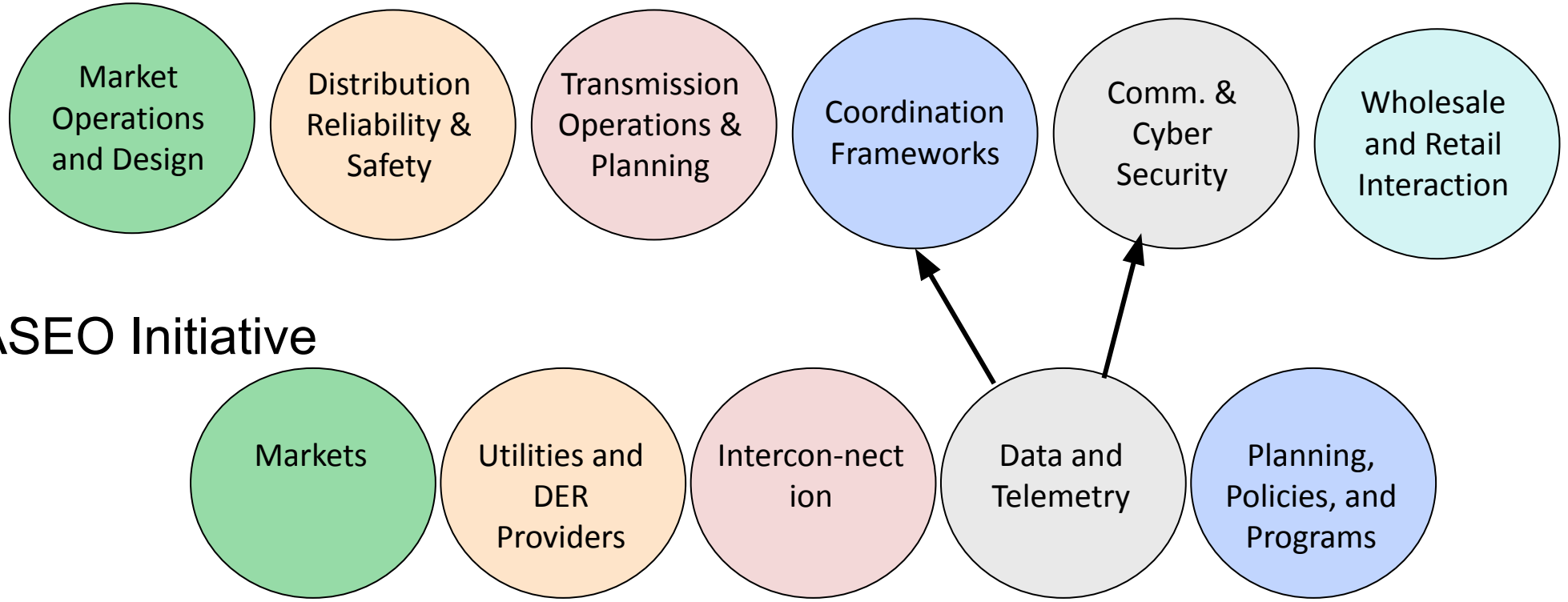

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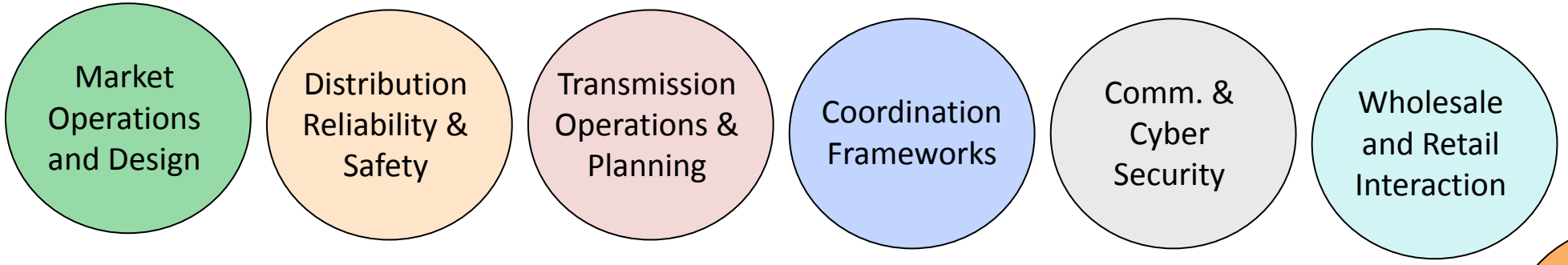

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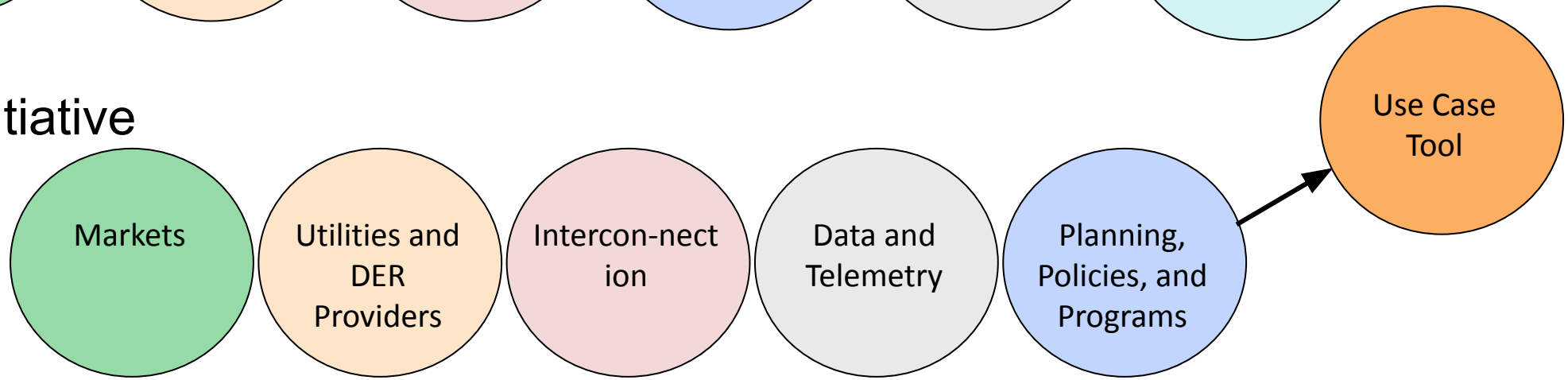

Final Report: Key Overarching Recommendations

Coordination, Education, Collaboration

Terminology Consistency

Begin granular, work up to collective mitigation strategies

Prepare for future evolution now

Harmonization is beneficial when possible

Unique Aspects of DER Market Design in the US ISOs/RTOs

- Some ISOs introduce new participation models, others use only existing
- DERs not eligible for explicit grid services in some ISOs
- Some ISOs allow aggregation across multiple transmission nodes, most others do not
- Settlement adjustments vs. bid floor approach for demand response resources part of DERAs (Order 745)
- Some size limits introduced for multi-node DERA or single DER in a DERA

FERC Order 2222 Aspect	NYISO	PJM	SPP	ISO-NE	MISO	CAISO
Participation Model	❖ Most ISOs are proposing a new participation model to allow for aggregations of DR with non-DR resources.					
	New: **"DER and Aggregation"** Existing: Homogeneous aggregations may elect existing models.	New: **DERA** Existing: **GEN, ESR, DR, EE**	Existing: **DDR, BDR, GEN, MSR, MCR, DVER** for homogeneous; **GEN, MSR** for heterogeneous	New: **SODERA, DRDERA** Existing: **GEN, CSF, BSF, DRR, ATRR**	New: **DERA** utilizing ESR functionality Existing: **DIR, ESR**	New: **DERP, "Heterogeneous DERA"** Existing: **GEN, NGR**
Eligible Wholesale Market Services	❖ All ISOs are proposing to allow DERAs provide wholesale energy service.					
	Energy, Ancillary Services (AS), Installed Capacity Market. Not eligible for Voltage Support. To be eligible for AS, each DER must be eligible.	**Energy, AS (Regulation, Synchronized Reserve, Black Start), Capacity.** Modeled as energy-only resources (no commitment)	**Energy, AS (Reserves and Regulation).**	**Energy, AS (Reserves and Regulation), Forward Capacity Market (FCM)** through Distributed Energy Capacity Resource (DECR).	**Energy, AS (Reserves and Regulation).**	**Energy, AS (Reserves and Regulation).** Not eligible for Resource Adequacy (RA) as qualifying capacity counting rules do not exist for DERAs in California.

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Final Report: Topical Findings and Recommendations

Workstream results

Final Report Outline

- Introduction and Motivation
- FO222 Summary and RTO filings or latest designs (since end of 2021)
- Key Challenge Areas by Workstream
- Conclusions and Next Steps

https://www.epri.com/research/products/000000003002020599

Market Operations and Design

Key Findings from Workstream 1

WS1
Market Ops & Design

Participation Models

- Existing models – Simple, easier timeline
- **New participation models** to represent unique DERA characteristics

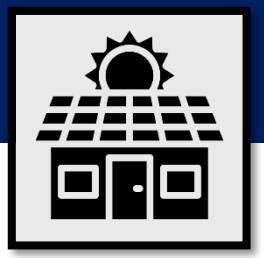
Demand Response

- Ensure compliance with FERC O745 in heterogeneous DERA
- Potentially **complex settlement procedures**

Energy Storage

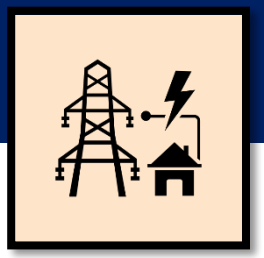
- SOC consideration for feasibility & reliability
- DERA **self-management of SOC** given complexities and software computational limits

Renewable Energy



- **Who provides VER forecast** information for a heterogeneous DERA
- Consideration of Non-performance penalties for VER DERAs

Locational Requirements



- Multiple transmission pricing node aggregation impact on system reliability & price formation
- What is **geographically broad as technically feasible**?

Challenges primarily around multi-node, multi-technology DERA participation

Market Operations and Design

Key Recommendations from Workstream 1

WS1
Market Ops & Design

Computation Times

- Assess **market clearing time** impact of different participation options
- Unit commitment impacts

Alternative DR Models

- DR models for O745 and beyond O745

Conduct Studies

- Conduct **system impact studies** with simple mixed DERA models for reliability implications of high DERA penetration

Appropriate Modeling

- Determine appropriate market software modeling and any needed enhancements incl. **distribution system impacts** in offers

Determine Locations

- Conduct technical studies to identify **appropriate DER aggregation zones**

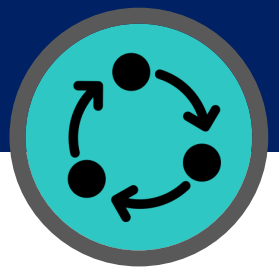
Studies to evaluate computation and efficiency with different heterogenous DERA levels

Distribution Operations and Planning

Key Findings from Workstream 2

WS2
Distribution Ops & Planning

Interconnection

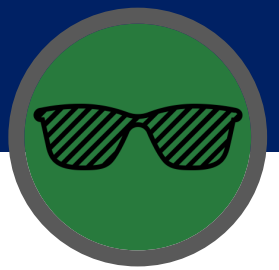


- Current study practices may not capture aggregate impact from bulk system services
- Firm capacity standards buy utilities some time to prepare for operational override needs

Registration

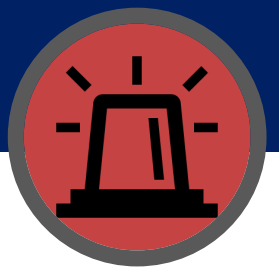
- Coordination with ISO/RTO and State/Local regulators needed to establish dual participation rules
- Enhanced data repositories or DER systems of record will enable quick access and sharing

Visibility



- Monitoring and visibility of BTM DER is limited or non-existent
- Advanced forecasting and state estimation may be sufficient to provide needed situational awareness

Control



- Rules based approach to DER management will persist until tools allow just-in-time analytics
- Communication pathways with devices and/or aggregators are needed to enable override command

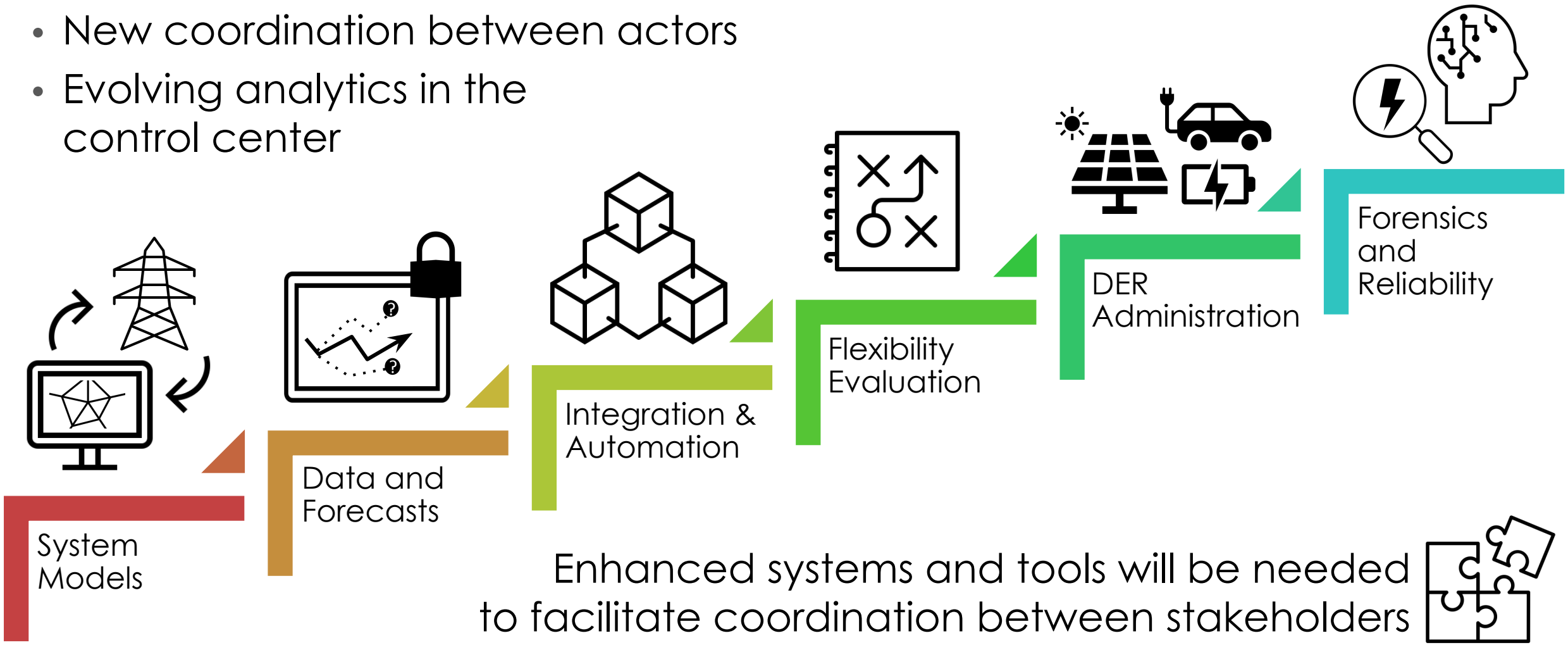
Metering

- Metering configurations and rate structures vary between states and regions
- Requirements must balance visibility, cost of entry, and ability to audit performance

Priority Implementation Opportunities

WS2
Distribution Ops & Planning

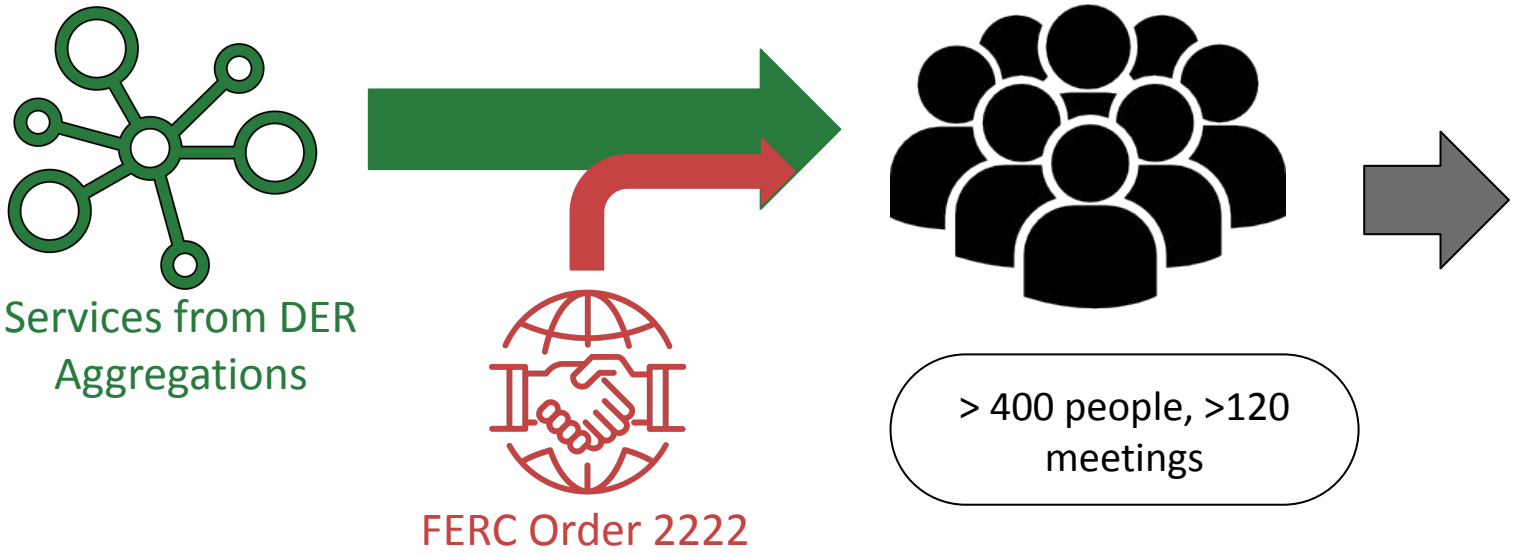
- Additional systems to enable participation
- New coordination between actors
- Evolving analytics in the control center



Enhanced systems and tools will be needed to facilitate coordination between stakeholders

Results from the TSO-DSO Coordination Workstream

WS4
Coordination Frameworks



- Provided stakeholders with a complete framework for coordination regarding DER services
- Addressed fundamental needs for TSO, DSO & aggregator coordination through a menu of standard technical functions
- Informing functional requirements of planning and operational control systems e.g., EMS, MMS, DMS, DERMS, CIS, SCADA

TSO-DSO Coordination Functions for DER. EPRI. Palo Alto, CA: 2022. 3002021985 [Online] https://www.epri.com/research/products/000000003002021985

Results from the TSO-DSO Coordination Workstream

WS4
Coordination Frameworks

FUNCTION	TIMEFRAME						TYPICAL ROLES
	Enroll/ Pre-Event	Day-Ahead Markets	Interim	Real-Time Markets	Service Period	Post-Event	
DER Device ID Assignment	X						AGG→DSO
DER Device ID Discovery	X						ISO→DSO, AGG→DSO, DEROwner→DSO
DER Resource ID Assignment	X						AGG→DSO
DER Resource ID Discovery	X						ISO→DSO, AGG→DSO, DEROwner→DSO
DER Group Creation	X						AGG→DSO, DSO→AGG AGG→ISO
DER Group Version							AGG→DSO

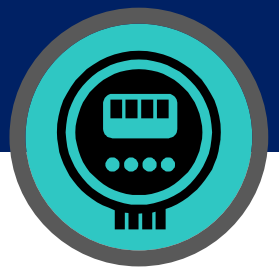
Coordination functions address timeframes from registration to settlement

Information, Communications, and Cyber Security

Key Findings from Workstream 5

WS5
Information
Comm. Cyber
Security

Metering



- Collaboration models will include the sharing of meter data from the DER owner to the aggregator to the ISO/RTO.
- Data ownership makes this challenging.

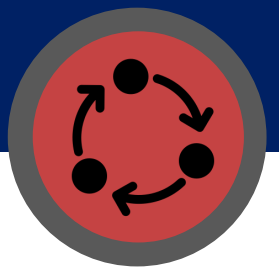
Telemetry

- Telemetry and cost of telemetry will play a critical role for participation of DERs in the ISO/RTO markets.

Data and Info

- Little standardization across the North American ISOs/RTO.
- There is likely to be an exchange of third-party data
- DERAs seeking to participate in multiple markets are faced with significant costs of building interfaces unique to each market

Interoperability



- FERC O2222 creates a complex coordination equation between DERA, DU, ISO, and DER
- Experience shows that when interoperability is low, integration costs tend to be high.

Cyber Security

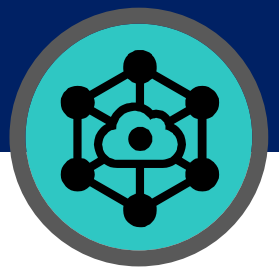
- FERC O2222 presents a major paradigm shift where expanded use of public networks and third-party systems is required to fulfill expected interoperability functions.

Information, Communications, and Cyber Security

Key Recommendations from Workstream 5

WS5
Information Comm. Cyber Security

Sharing Meter Data



- Aggregators and ISO/RTOs should utilize standard meter data exchange mechanisms
- NAESB ESPI standardizes the necessary business practices (e.g. Green Button, Smart Meter Texas)

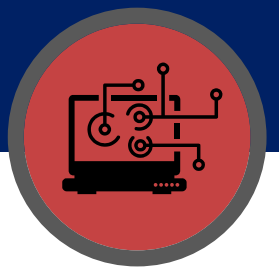
Clear Telemetry Guidelines

- ISO/RTOs must have clear guidelines that align with planning and operational needs, consider cost to DERAs, and align with rules for similar services.

Standardize Market Interfaces

- Important to re-use existing data formats and exchange mechanisms
- It will be beneficial for exchange mechanisms to be coordinated across market operators for consistency and that they are submitted to a standards organization.

Leverage Existing Standards



- Leverage today's connectivity and data standards between DUs, DERAs, and DERs.
- Develop scalable architectures built on standards (e.g. Federated Architectures for DER Integration)

New Cyber Frameworks

- Interfacing grid entities must establish their own security protocol.
- A chain-of-trust framework will be required to inform the proper security protocols to be coordinated across a multi-party grid.

Dual Participation Perspectives

Key Findings from Workstream 6

WS6
Customer Tech. & Retail Programs

ISO/RTO

- Possibility of dual **registration** and **reserve/commitment** in wholesale & retail, but **dispatch** for up to 1 service at a time
- Resource meets wholesale **requirements**, same service **not doubly** compensated, and **utility consents**

Distribution Utility

- Differing views on dual commitment & dispatch: Local capacity + reserve Local capacity + energy
- **Technically compatible** program combo, **first right** to dispatch DER (that DU registered first), and **requisite metering** in place to avoid dual pay

Load Serving Entity

- DR/DER aggregator of capacity for ISO dispatch
- **First right** of dispatch for own retail programs (independent of market dispatch)
- DER impact on load **aggregator business** and **systems**
- **Allocation of settlement** costs for DER dispatch

Third Party Aggregator

- Favor dual participation for **maximum return**
- Any **restrictions narrowly tailored**, with the ISO well-positioned to place checks, so long as utility is agreeable
- Accommodate **DER export** with **DER-level metering** or telemetry

Customer Advocacy

- DER technology adopters with financial interest in **expanded value streams** to better capitalize BTM DER and enhance returns
- Non-adopters **(limited income)** consumers likely to **bear higher share** of costs to maintain grid infrastructure

Double Counting

Key Recommendations from Workstream 6

WS6
Customer Tech. & Retail Programs

Reconstitute where Submeter

- Reconstitute the metered load to avoid double counting sub-metered DER
- Back out the contribution of DER from the facility-level meter already accounted for when submetering

Advanced Metering

- Adopt Dual Port or Multi-Port Metering
- Alternative to sub-metering, net metering, or separately metering DER
- Measures grid-supplied vs. DER-supplied power; calculable quantity of customer facility load

Align Retail with Wholesale

- Align Retail Billing Structures with Wholesale Cost Drivers

Consider Demand Charges

- Consider Unbundled Demand Charges for DER Customers

Advance Retail Programs

- Enable Impactful Customers by Advancing Retail Rates

FERC Order 2222 Status

- **CAISO:** FERC-approved "DERP" model in 2016
  - Compliance filing: July 2021
  - FERC deficiency letter: Oct. 2021
  - Answers to FERC: Nov. 2021
- **NYISO:** FERC-approved "DER and Aggregation" Model in Jan. 2020
  - Compliance filing: July 2021
  - FERC deficiency letter: Oct. 2021
  - Answers to FERC: Nov. 2021
- **PJM**
  - Compliance filing: Feb. 1, 2022
- **ISO-NE**
  - Compliance filing: Feb. 2, 2022
- **MISO:** Yet to submit by Apr. 18, 2022
- **SPP:** Yet to submit by Apr. 28, 2022

Multi-state ISOs/RTOs who did not have existing designs had approved extensions on compliance filings.

Summary of RTO/ISO Distributed Energy Resource Aggregation Market Design Proposals

FERC Order 2222 Aspect	NYISO	PJM	SPP	ISO-NE	MISO	CAISO
Participation Model	❖ Most ISOs are proposing a new participation model to allow for aggregations of DR with non-DR resources.					
	New: **"DER and Aggregation"** Existing: Homogeneous aggregations may elect existing models.	New: **DERA** Existing: **GEN, ESR, DR, EE**	Existing: **DDR, BDR, GEN, MSR, MCR, DVER** for homogeneous; **GEN, MSR** for heterogeneous	New: **SODERA, DRDERA** Existing: **GEN, CSF, BSF, DRR, ATRR**	New: **DERA** utilizing ESR functionality Existing: **DIR, ESR**	New: **DERP, "Heterogeneous DERA"** Existing: **GEN, NGR**
Eligible Wholesale Market Services	❖ All ISOs are proposing to allow DERAs provide wholesale energy service.					
	Energy, Ancillary Services (AS), Installed Capacity Market. Not eligible for Voltage Support. To be eligible for AS, each DER must be eligible.	**Energy, AS (Regulation, Synchronized Reserve, Black Start), Capacity.** Modeled as energy-only resources (no commitment)	**Energy, AS (Reserves and Regulation).**	**Energy, AS (Reserves and Regulation), Forward Capacity Market (FCM)** through Distributed Energy Capacity Resource (DECR)**.**	**Energy, AS (Reserves and Regulation).**	**Energy, AS (Reserves and Regulation).** Not eligible for Resource Adequacy (RA) as qualifying capacity counting rules do not exist for DERAs in California.

ATRR: Alternative Technology Regulation Resource, **AS:** Ancillary Services, **BDR:** Block Demand Response, **BSF:** Binary Storage Facility, **CSF:** Continuous Storage Facility, **DDR:** Dispatchable Demand Response, **DERA:** Distributed Energy Resource Aggregation, **DERP:** Distributed Energy Resource Provider, **DIR:** Dispatchable Intermittent Resource, **DR:** Demand Response, **DRDERA:** Demand Response DERA, **DRR:** Demand Response Resource, **DVER:** Dispatchable Variable Energy Resource, **EE:** Energy Efficiency, **ESR:** Electric Storage Resource, **GEN:** Generator, **MCR:** Multi Cycle Resource, **MSR:** Market Storage Resource, **NGR:** Non-Generator Resource, **SODERA:** Settlement-Only DERA.

Summary of RTO/ISO Distributed Energy Resource Aggregation Market Design Proposals

FERC Order 2222 Aspect	NYISO	PJM	SPP	ISO-NE	MISO	CAISO
Locational Requirements	❖ Most ISOs are proposing single transmission pricing node aggregations.					
	Single Transmission Pricing Node More similar to a combination of single and multi-node aggregation. NYISO identifies the DER aggregation locations considering historical congestion and other system conditions.	**Single Transmission Pricing Node** if providing energy service **Multi Transmission Pricing Node** if providing Capacity or Ancillary-Service Only	**Single Transmission Pricing Node**	**Multiple Transmission Pricing Nodes** Intersection of DRR Aggregation Zone and Metering Domain	**Single Transmission Pricing Node**	**Multiple Transmission Pricing Nodes** Single Sub-Load Aggregation Point (Sub-LAP)
Metering Requirements	❖ All ISOs except for PJM and MISO require aggregate-level meter data.					
	Aggregated Revenue Quality Meter data Multiple streams (energy injections, energy withdrawals, and demand reductions). Individual DER data could be directly measured or calculated values.	**Individual DER Settlement Quality Meter data** Hourly or 5-min granularity.	**Aggregated Revenue Quality Meter data**	**Aggregated Revenue Quality Meter data** Hourly or 5-min (optional) granularity.	**Individual DER and "DER Group" Settlement Quality Meter data** A "DER Group" is a subset of DERs that are homogeneous and have the same M&V.	**Aggregated Settlement Quality Meter data** Multiple streams (energy injections, withdrawals, and demand reductions). Individual DERs must be directly metered.

DRR: Demand Response Resource, **NYTO:** New York Transmission Owner, **Sub-LAP:** Sub-Load Aggregation Point.

Summary of RTO/ISO Distributed Energy Resource Aggregation Market Design Proposals

FERC Order 2222 Aspect	NYISO	PJM	SPP	ISO-NE	MISO	CAISO
Telemetry Requirements	❖ Most ISOs require aggregate-level real-time telemetry from all DERAs.					
	Aggregated Real-Time Telemetry Multiple streams (energy injections, energy withdrawals, and demand reductions). Individual DER data could be directly measured or calculated values.	**Aggregated Real-Time Telemetry** Scan rate 2s for Reg-D, 10s for Reg-A, 1-min for other AS and Capacity, 1-min for Energy if larger than 10 MW. Calculated values are acceptable for individual DERs.	**Aggregated Real-Time Telemetry**	**Aggregated Real-Time Telemetry** SODERA: no requirements. GEN, BSF, CSF: 10s or 2s (if providing regulation) DR, DRDERA: individual DER telemetry at 1- or 5-min rate	**Aggregated Real-Time Telemetry** Scan rate of 2s for all DERAs	**Aggregated Real-Time Telemetry** Only if DERA size is larger than 10 MW or provides Ancillary Services.
Application of Net Benefits Test (Order 745)	❖ Most ISOs apply the Net Benefits Test to heterogeneous DERAs in after the fact settlement stage.					
	Settlement Adjustment Only applies to DR DERs within a DERA.	**Settlement Adjustment** Only applies to DR DERs within a DERA.	**Settlement Adjustment** Only applies to DR DERs within a DERA.	**Bid-Floor Approach** Applies to both injecting DERs and DR DERs within a DRDERA. ***Injecting DERs can self-schedule and get paid at LMP if do not clear the market.***	**Settlement Adjustment** Only applies to DRs within a DERA.	**Bid-Floor Approach** Applies to both injecting DERs and DR DERs within a DRDERA. Cannot provide services if not cleared.

BSF: Binary Storage Facility, **CSF:** Continuous Storage Facility, **DERA:** Distributed Energy Resource Aggregation, **DR:** Demand Response, **DRDERA:** Demand Response DERA, **GEN:** Generator, **Reg-A:** Slower regulation product in PJM typically used for non-storage resources, **Reg-D:** Faster regulation product in PJM typically used for electric storage resources, **SODERA:** Settlement-Only DERA.

Summary of RTO/ISO Distributed Energy Resource Aggregation Market Design Proposals

FERC Order 841 Aspect	NYISO	PJM	SPP	ISO-NE	MISO	CAISO
Maximum Size (Individual DERs)	❖ Most ISOs require larger DERs to participate as stand-alone resources or be the only resource in the DERA.					
	20 MW	**5 MW:** Individual DER larger than 5 MW must select other participation models (Gen, DR, etc.)		**SODERA: 5 MW** Other models: If larger than 5 MW, must be its own DERA		**1 MW**
Maximum Size (DERA)	❖ Only ISOs allowing multiple pricing node aggregations impose size requirements on aggregations.					
				5 MW on total DER size at each pricing node if aggregated across multiple pricing node		**20 MW** if aggregated across multiple pricing nodes
Effective Date	**Fourth quarter of 2022**	• Rules around capacity market: **July 2023** • All other rules: **Feb. 2026**		• Rules on Forward Capacity Market: **Nov. 2022** • Rules on Energy, and Ancillary Services: **Nov. 2026**		**Nov. 2022**

SODERA: Settlement-Only DERA.

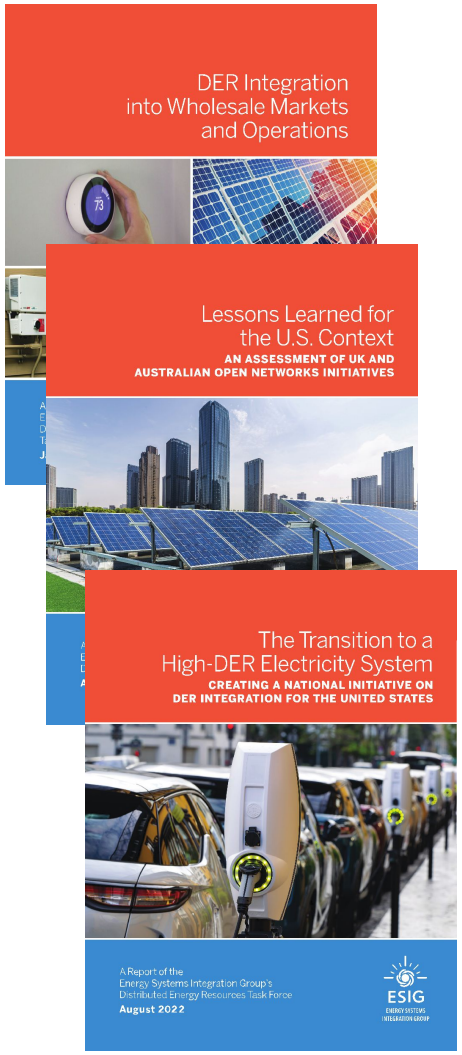
DER Integration into Markets and Operations

Debra Lew, Associate Director, ESIG

Speaking on behalf of DER Task Force including Priya Sreedharan, Matt McDonnell, Fritz Kahrl, Lorenzo Kristov, Josh Keeling, Jennifer Gorman, Jason Brogden, Obadiah Bartholomy

Sep 20, 2022

ESIG three-part series on DER integration



DER Integration into wholesale markets and operations.
Examines the changes in regulation, market rules, planning, and operating practices needed to better integrate DERs into U.S. wholesale markets and operations, addressing both near term opportunities and long-term needs.

Lessons Learned for the U.S. Context: An Assessment of UK and Australian Open Networks Initiatives. Reviews the UK and AU open networks initiatives and highlights elements that could be useful to incorporate in a US initiative on DER integration and characteristics from each initiative that should be avoided.

The Transition to a High-DER Electricity System: Creating A National Initiative for DER Integration for the United States. Leveraging the first two reports and inputs from the task force, this report clarifies the need, value and design of a potential US national initiative.

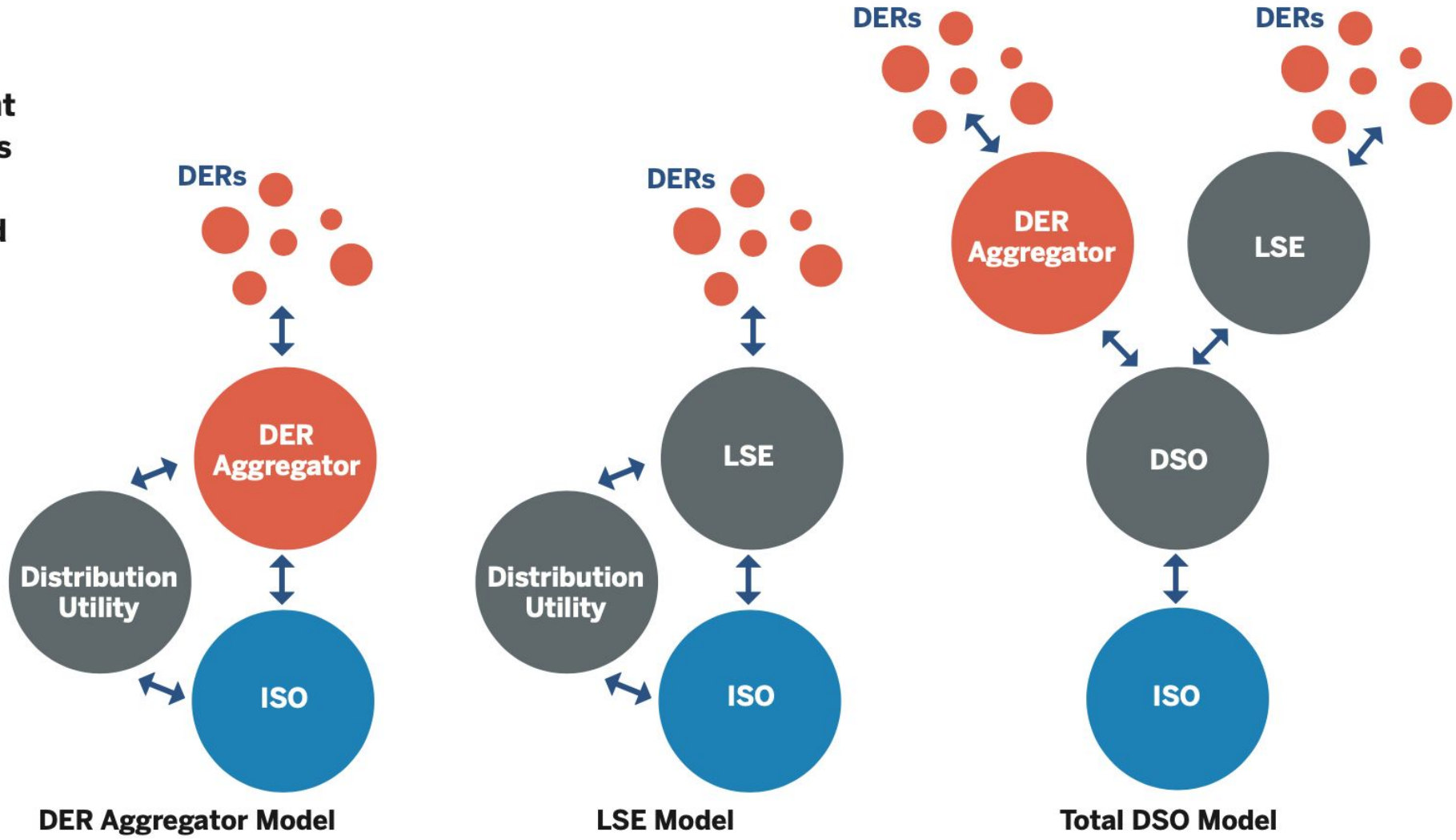
https://www.esig.energy/der-integration-series/

Focus in on market operations

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

We examined three structural participation models

Structural participation models describe different approaches for how DERs participate in wholesale markets; they vary based on the nature of the interactions among the ISO, distribution utility, and DER aggregator.

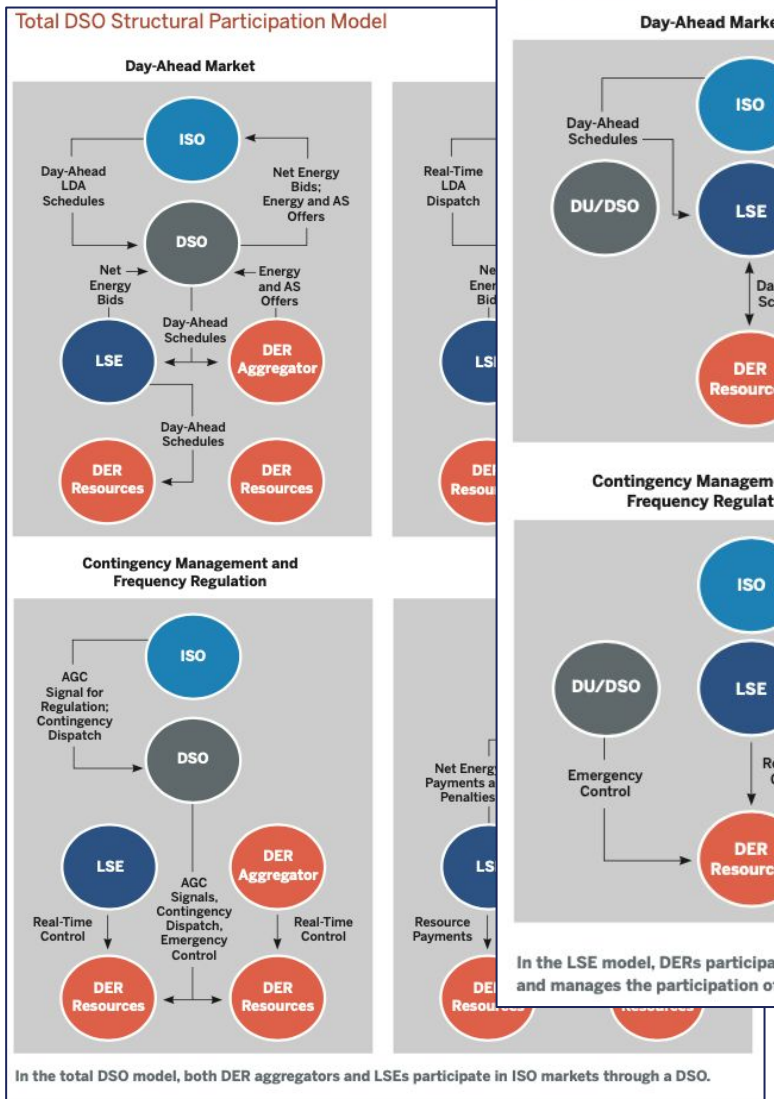


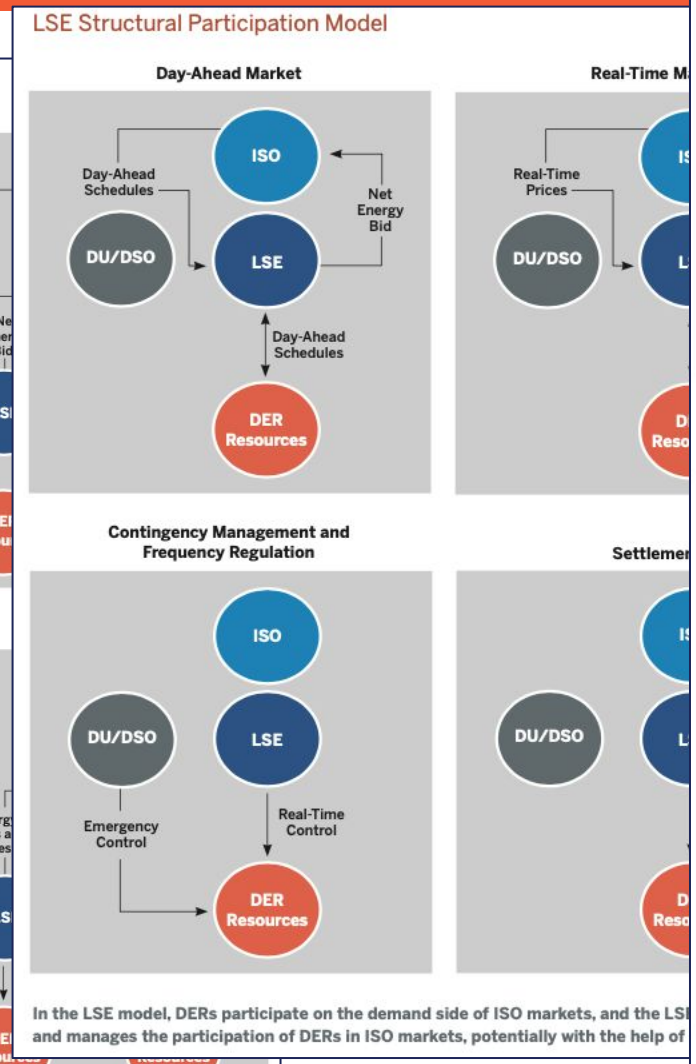
DER Aggregator Model

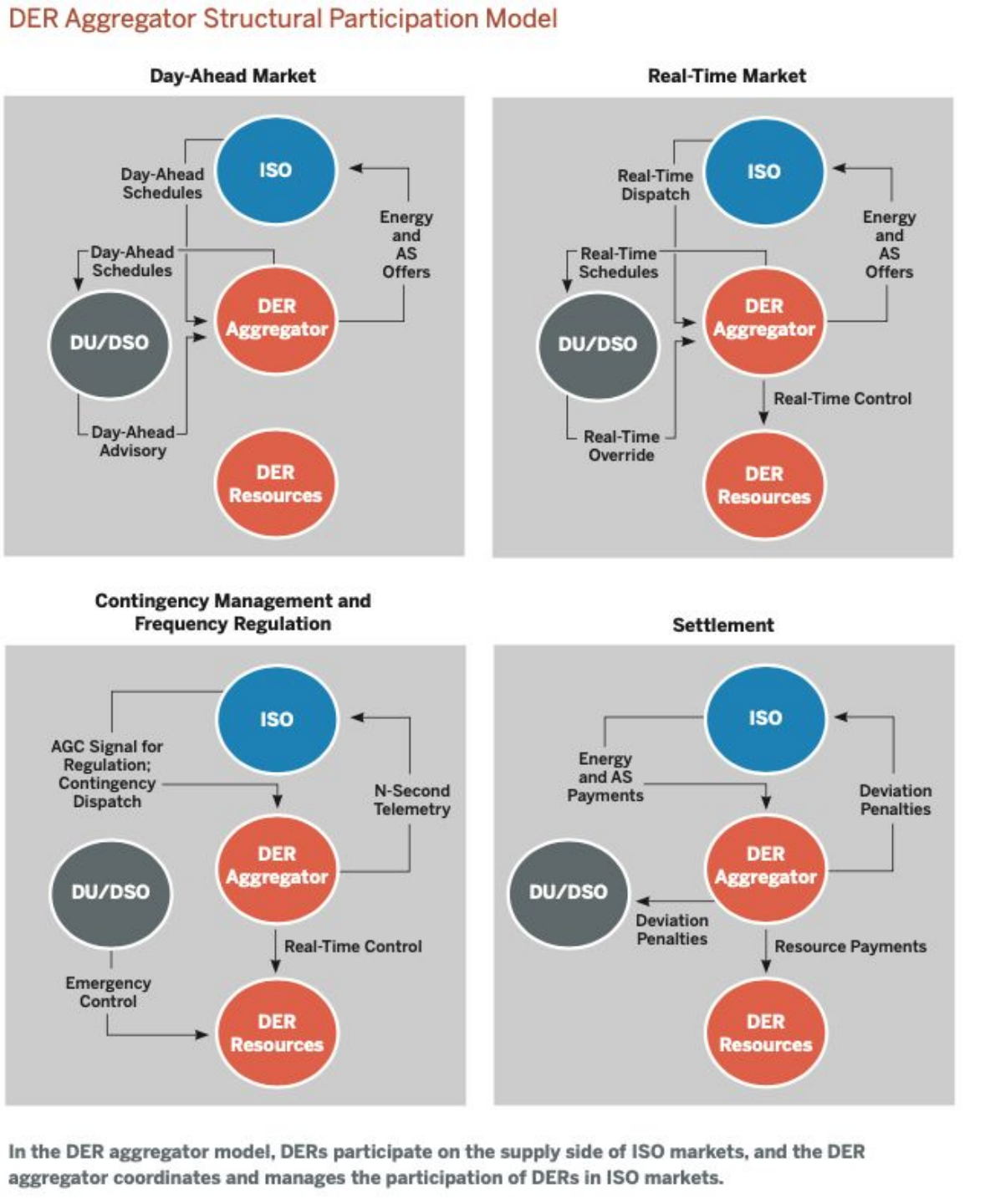
LSE Model

Total DSO Model

We examined market operations across the different models







Market Processes and Operator Functions

Pre-operations and Planning

Market Process	Operator Function	
	DU/DSO	ISO
Registration of market participants and resources	Register market participants (DER providers) and participating resources (DERs or DERAs)	Register market participants (DER providers) and participating resources (DERs or DERAs)
Distribution planning	Plan investments in distribution infrastructure and non-wires technologies	Provide DU/DSO with timely information on planned transmission expansion
Transmission planning	Provide ISO with i and DER forecasti	
DER interconnection	Set interconnecti screens and studi	
Resource verification	Review DERA; rev communications	
Resource adequacy	Verify deliverabilit	
Maintenance scheduling	Manage and repo equipment outag	

Market and System Operations

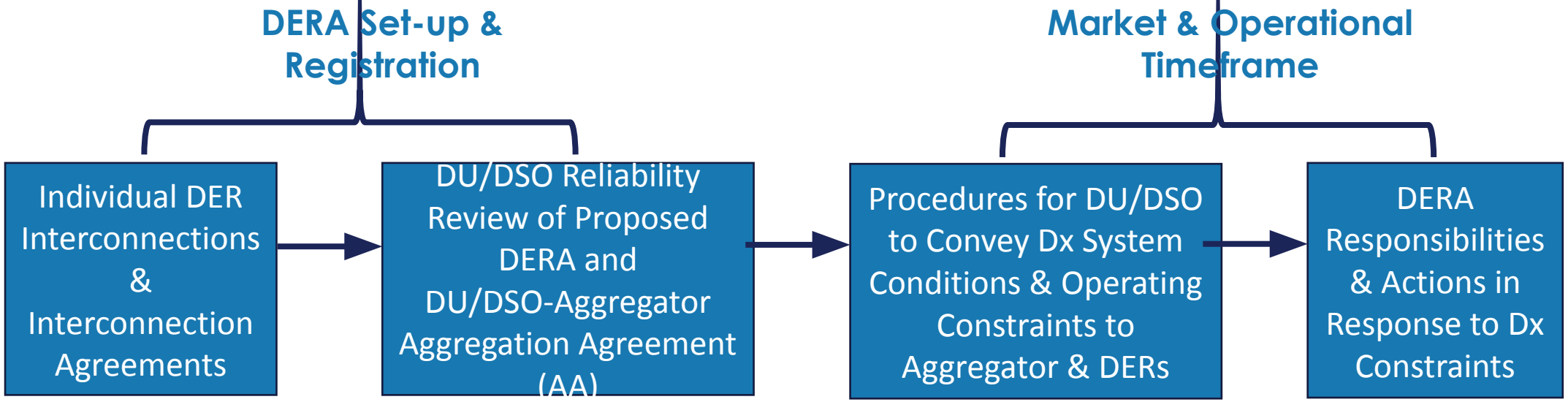
Market Process	Operator Function	
	DU/DSO	ISO
Day-ahead market	Schedule DERs that provide distribution grid services to the DU/DSO	Perform scheduling and unit commitment
Real-time market	Dispatch DERs that provide distribution grid services to the DU/DSO; ensure distribution system security and, in some models, perform economic dispatch	Perform security-constrained economic dispatch
Contingency management	Manage outages and provide emergency control	Manage outages and provide contingency dispatch
Frequency balancing		
Voltage regulation		

Market Settlement

Market Process	Operator Function	
	DU/DSO	ISO
Market settlement	Assess penalties for DERs' or DERAs' non-compliance with override instructions; perform market settlement in some models	Settle day-ahead energy, real-time energy, and ancillary service markets; assess imbalance penalties
Network tariffs and settlement	Settle non-wires resources; distribution tariffs; and tariffs for generation, storage, and demand response	Settle transmission tariffs

Operational Coordination Architecture

- Provide a framework for the distribution utility (DU) or distribution system operator (DSO) to manage reliability impacts to distribution resulting from aggregations of DERs (DERA) participation in the ISO market under changing distribution system conditions.
- Satisfy FERC 2222 requirements for DU/DSO to implement “transparent, non-discriminatory” procedures for over-riding ISO dispatches (para 310).
- Minimize real-time transaction complexity via effective Interconnection Agreement and Aggregation Agreement provisions



In the future, these agreements could include flexible interconnection (dynamic curtailment)

See example

Transparent, Non-Discriminatory Provisions for DU/DSO Curtailment of DERA Dispatch

- These procedures would probably live in a DU/DSO tariff, with references in the Interconnection Agreement and Aggregator Agreement.
- Transparency requires clear specification of the causes of curtailment, compliance requirements, penalties, etc.
- Non-discriminatory requires fair allocation of limited distribution capacity between multiple DERAs that may use some of the same capacity

DERA Curtailment Options

Simple Approaches

- Full curtailment of all net injecting DERs on a circuit in abnormal configuration
- Pro rata curtailment based on installed capacity
- “First-in-last-curtailed” (e.g., based on commissioning date)

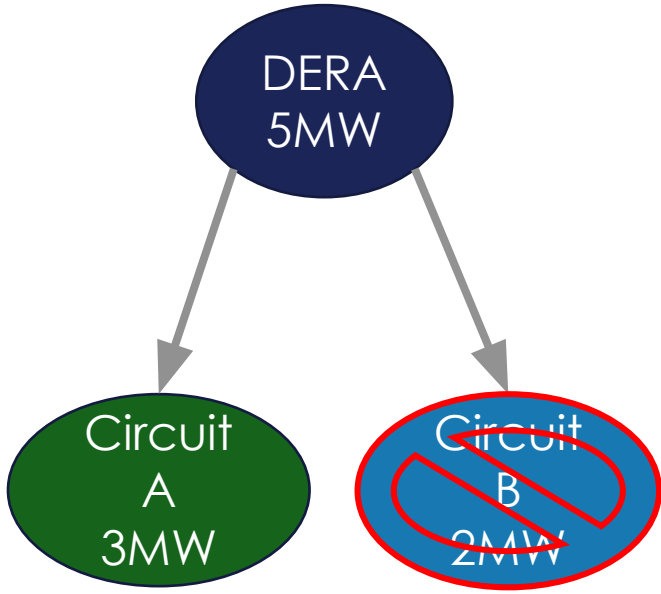
More Complex Approaches

- Physical rights for non-firm (flexible) access to the dist. system are curtailed first
- Economic curtailment
- Economic dispatch of a distribution-level energy market operated by the DU/DSO

Example: Day-to-Day ISO Market and Operational Coordination

DERA in CAISO with 5 MW capacity comprised of individual DERs over two distribution circuits within a single T-D interface. Circuit A hosts 3 MW and circuit B hosts 2 MW. At 9 am Monday the DU/DSO informs the Agg of a problem that has taken out distribution circuit B that will continue for the next 24 hours.

1. The Agg immediately submits an outage/derate card to CAISO indicating DERA capacity reduction from 5 MW to 3 MW for HE10 Monday through HE09 Tuesday
2. The Agg structures its DA market offers for the DERA for Tues to reflect maximum 3 MW for HE01-09 and maximum 5 MW for HE10-24 (based on the expected duration of the circuit B outage)
3. The Agg structures its RT market offers for Monday HE12-24 based on maximum 3 MW capacity; this may involve buying back portions of the DERA's DA schedules (which cleared in Sunday's DAM) for hours where they exceed 3 MWh.
4. The CAISO does not receive new RT offers for 5-minute intervals from 0910 until 1100, but the market optimization knows from the outage/derate card that the DERA's maximum output is 3 MW, so it will not dispatch the DERA for more than 3 MW capacity in any interval.
5. For the interval 0900-0910 the CAISO does not perform any new market optimization, so its previously issued dispatches to the DERA would reflect 5 MW capacity. Thus the DERA may fall short of its DA schedule or RT dispatch. The imbalance on the CAISO system is managed by Regulation (AGC) and will subject the DERA to imbalance energy charges and possibly uninstructed deviation penalties.



Recommendations to enable DER integration in wholesale markets

For those at an early stage of DER integration, these strategies can help:

1. **START WITH MINOR CHANGES.** Begin from an assumption that relatively minor changes in distribution planning, distribution operations, and utility investments in monitoring and controls necessary to support them will be needed for near-term compliance with Order 2222 (commissions, utilities).

2. **LEVERAGE EXISTING DATA.** Leverage data from DER registration and interconnection in DER aggregation reviews to minimize the need for additional study during reviews; in most cases, DER aggregation review should not require redoing interconnection studies (commissions, utilities).

3. **USE EXISTING PROCESSES FOR COMMUNICATIONS AND DATA-SHARING.** Rather than create new processes and additional complexity, make use of existing protocols and processes for communications and data-sharing among utilities, aggregators, and ISOs/RTOs (utilities, DER aggregators, ISOs/RTOs).

4. **DEVELOP WORKABLE APPROACHES TO UTILITY OVERRIDES.** Focus initially on developing workable approaches to utility overrides, based on a foundation of efficient communication between utilities and aggregators, with terms and conditions that are clearly articulated in interconnection and aggregator agreements and can evolve over time (utilities, commissions, aggregators).

5. **PRIORITIZE ADOPTION AND IMPLEMENTATION OF IEEE 1547-2018.** Voltage support provided through compliance with interconnection standards may reduce the need for overrides and distribution upgrades (commissions, utilities).

National dialogue

PARTICIPATE IN NATIONAL, INDUSTRY-WIDE DIALOGUE.

6

- Build:
  - A **common vocabulary, framework, and vision** for thinking about DER integration across different jurisdictions
  - A common understanding around **shorter-term, least-regrets strategies for DER integration that are consistent across distribution utilities**, including strategies for enhancing distribution and transmission planning, data-sharing and communication, distribution operations, and DER interconnection and aggregation review
  - A **structured dialogue on solutions to longer-term issues around DER integration**, such as the design of distribution system operator (DSO) operations, markets, and regulation, federal-state jurisdictional overlap, independent system operator (ISO) market design, and incentive frameworks for regulated utilities
- Develop a general framework and terminology for considering distribution system operations, markets, and regulation with higher levels of DERs
- Identify nearer-term least-regrets DER integration enhancements and solutions that are grounded in power system engineering and economics and could be applicable to diverse jurisdictions
- Develop a portfolio of potential longer-term DSO models and TSO-DSO coordination arrangements that each jurisdiction could tailor to their individual needs, rather than develop a one-size-fits-all approach

THANK YOU

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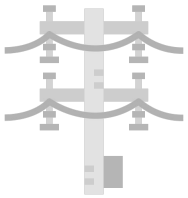
Key areas and actions for regulatory commissions and distribution utilities to support FERC Order 2222 compliance

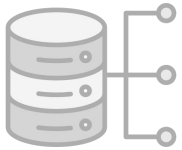
	Actions Needed by Commissions	Actions Needed by Distribution Utilities
Interconnection procedures	Ensure that interconnection procedures are transparent, are fair, and conform to predictable costs and time frames	Develop new or enhance existing DER interconnection procedures to establish DER performance parameters (e.g., maximum injection limits) and utilities' ability to curtail DER power injections for reliability purposes
DER aggregation review	Ensure that utility aggregation review is timely, fair, and flexible, avoiding the need for new interconnection studies	Develop transparent procedures for review within 60 days of an aggregator proposing a DER aggregation
Outage communication	Ensure that distribution utility outage communication is timely and fair, allowing DER providers to manage non-performance risks in the wholesale market	Develop new processes and capabilities for communicating distribution outages or constraints to DER aggregators
Utility overrides	Ensure that distribution utility overrides are transparent and non-discriminatory	Develop transparent, non-discriminatory procedures for overriding ISO/RTO scheduling and dispatch of DERs that align with expectations set within the aggregation review process

Broader gaps for DER market and system integration beyond Order 2222



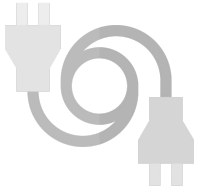
TRANSMISSION AND DISTRIBUTION PLANNING

- Integrate approach to distribution planning, interconnection, and operations
- Increase coordination between distribution and transmission planning



DISTRIBUTION OPERATIONS

- Identify least-regrets enhancements in visibility, communications, DER operations, and real-time controls that will be needed
- Allocate responsibilities for active coordination of DER activity between the distribution system operator and the ISO/RTO



DISTRIBUTION INTERCONNECTION

- Determine setpoint guidance for smart inverters, given distribution systems' needs
- Define how utilities should determine minimum reliability upgrades versus upgrades that could be avoided through DER curtailment or re-dispatch
- Determine how utilities ensure that procedures for curtailing or re-dispatching flexible interconnections are transparent and non-discriminatory

Broader gaps for DER market and system integration beyond Order 2222 *(continued)*

COMMUNICATIONS AND DATA-SHARING

- Enable increased communication between distribution utilities or distribution system operators and ISOs/RTOs, including during day-ahead and intraday scheduling, real-time dispatch, automatic generation control signals, and emergency operations
- Increase available information on loads, anticipated load growth, and DERs in the interconnection queue

ISO/RTO MARKET DESIGN

- Implement market design changes to enable market-based approaches to load participation during the operating day

MARKET REGULATION

- Ensure that distribution operators' overrides of DER schedules and dispatch and dispatch of DERs are transparent and non-discriminatory
- Clarify issues around state-federal jurisdiction

UTILITY REGULATION AND BUSINESS MODELS

- Implement incentive frameworks that attempt to better align utility incentives with maximizing the system value of DERs
- Design tariffs to incentivize the flexibility that can be provided through energy storage and load management

Order No. 2222 – Preparing the Distribution Grid and Retail Programs to Maximize the Value of DERs for Customers

NARUC-NASEO DER Integration & Compensation Initiative Workshop

September 20, 2022

Goals for today

- **Introduce AEE-GridLab Report and Summarize Recommendations**
  - "FERC Order 2222 Implementation: Preparing the Distribution System for DER Participation in Wholesale Markets" (January 2022)
- **Zoom in on Dual Participation in Retail and Wholesale Markets**
- **Time Permitting: Update on Key Issues in Order No. 2222 Compliance Filings**

Note: "RERRA" = Relevant Electric Retail Regulatory Authority (i.e., states, municipalities, cooperative utility boards)

AEE's Vision of Successful Order No. 2222 Implementation

Wholesale market participation/compensation *complements* other values and revenue streams that DERs currently access (e.g., customer benefits and retail programs). This means:

- **Customers can deploy DERs more affordably,** because DERs receive compensation for *all* the services they can provide
- **DERs already being deployed add more value to the grid** by offering all the services they are technically capable of providing
- **DERs are deployed more rapidly and more efficiently,** because they are responding to transparent market signals
- **Reliability improves,** because grid operators gain visibility and control as DERs participate in wholesale markets
- **Wholesale competition is enhanced** as DERs participate

Introduction to AEE – GridLab Convening and Report

FERC Order 2222 Implementation: *Preparing the Distribution System for DER Participation in Wholesale Markets*

January 2022

ADVANCED ENERGY ECONOMY

GridLAB

ES

Background

- AEE and GridLab brought together utilities and AEE members to build consensus around key distribution system issues to facilitate DER participation in wholesale markets
- This summary lists key recommendations to help educate state commissions; inform FERC and RTO/ISO processes; and support state policies that increase DER value
- Four working groups formed to discuss: Interconnection and aggregation review; communications, controls, and coordination; dual participation; and investment recovery and cost causation

CAMPAIGN PARTICIPANTS

Microsoft
DTE
greenlots
A Member of the Shell Group
CLEAResult®
ecobee
Dominion Energy®
Google
Xcel Energy®
RECURVE
CPower
Portland General Electric
sp
uplight
enel x
ORACLE
Walmart
GridLAB
ADVANCED ENERGY ECONOMY

Other participants include: APS, Exelon, PECO, ComEd, Pepco, and BGE

ADVANCED ENERGY ECONOMY
GridLAB

Vision of Success

DER aggregators, distribution utilities, RTOs/ISOs, and utility customers may benefit from increased DER participation in wholesale markets, for example:

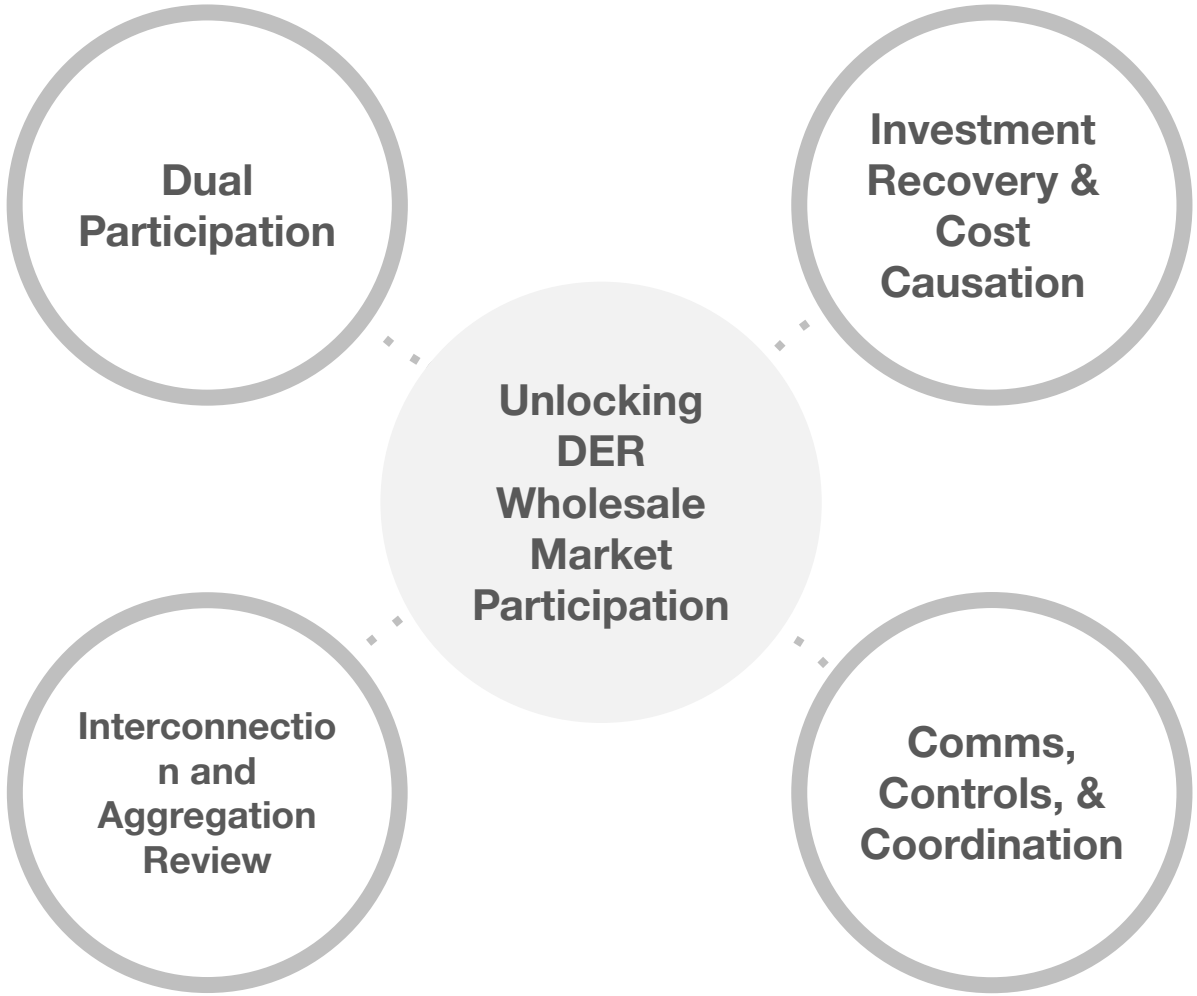
- **DER Aggregators:** Order 2222 opens new opportunities to earn revenue from wholesale markets; alongside distribution level compensation, this brings DERs closer to providing and being compensated for their full suite of benefits
- **Distribution Utilities:** Order 2222 creates an opportunity to play a role in enabling DER participation in wholesale markets while potentially deriving value from DERs at the distribution level
- **RTOs/ISOs:** Aggregated DER participation gives system operators access to more resources that increase grid flexibility and maintain reliability, particularly in the context of increasing renewables
- **Customers:** Utilization of DERs in wholesale/retail markets has the potential to lower overall customer costs by avoiding otherwise needed energy and capacity investments across the grid

ADVANCED ENERGY ECONOMY GridLAB

Order No. 2222 Overview: Key Compliance Requirements

Parameter(s)	Key Requirement(s)
Eligibility of DER aggregators/DER types	DER aggregators must be an eligible market participant; RTOs/ISOs must allow all technology types and multi-technology combinations; rules must prevent "double counting" in retail and wholesale markets; no broad state "opt-out"
Geographic scope of aggregation	Encourages broad geographic scope of aggregation, but allows RTOs/ISOs to propose to limit aggregations to a single pricing node
Distribution factors and bidding parameters	Must account for physical and operational characteristics of DER aggregations and ensure they are able to fully offer their aggregations into RTO/ISO markets
Information and data requirements	RTOs/ISOs are required to transparently state the information and data that DER aggregators must provide them about the performance, physical parameters, and components of their aggregations
Metering and telemetry requirements	RTOs/ISOs have flexibility to set these requirements, including whether to require metering and telemetry of individual DERs; must justify why they are necessary and explain why they do not result in undue barriers to participation
Coordination	Requires RTOs/ISOs to establish procedures for coordination between RTOs/ISOs, DER aggregators, distribution utilities, and state and local regulators

The collaborative prioritized four areas of focus and developed four Working Groups to address each



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Broad Conclusions

- DER aggregation in wholesale electricity markets under Order 2222 presents unique opportunities and challenges
- Order 2222 implementation will be most successful for customers and grid reliability with active engagement from state utility regulators
- Existing processes and tools developed by states, distribution utilities, and stakeholders to support DER integration should be built on to facilitate Order 2222 implementation
- In the future, processes and tools adopted by states and utilities related to DER adoption and integration should anticipate participation in wholesale aggregations
- New requirements and investments to support Order 2222 implementation should be aligned with the services provided and scaled as participation increases where possible
- Processes, tools, and policies enacted to support Order 2222 implementation must set clear expectations of all participants
- Equitably addressing the potential incremental distribution-level costs of Order 2222 implementation requires identification of a range of potential costs and benefits
- State regulators could consider establishing dedicated forums to examine and address the complex distribution system issues identified in this report

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Zoom In:

Dual Participation in Retail and Wholesale Programs

What is “dual participation?”

- *Ability to participate in both wholesale and retail programs, so long as DER is not receiving compensation for the same services as part of another program*.
- **Order No. 2222**: FERC required RTOs and ISOs to "allow [DERs] that participate in one or more retail programs to participate in its wholesale markets,” while allowing “appropriate restrictions” that are “narrowly designed to avoid counting more than once the services provided by distributed energy resources in RTO/ISO markets.”
- **Why does it matter**?
  - Dual participation is key to unlocking value given the operational and economic realities of DER aggregations; most are adopted for retail purposes first, but additional wholesale revenue streams can improve utilization and reduce costs (for DER owner and broader system)
  - Broad restrictions on DER participation that do not recognize reasonable operational limitations will diminish value and increase costs

Challenges of Dual Participation Identified by Working Group

- **Double Counting:** To the extent that a DER's wholesale participation coincides with the LSE/EDC peak demand and that participation impacts the amount of capacity for an ISO or LSE/EDC to procure, the DER's wholesale activities will need to be separately metered or added back to the peak load to ensure the ISO or LSE/EDC can accurately plan for system peak demand
- **Double Compensation:** Absent mechanisms to prevent duplicate payments, DERs engaged in dual participation may inappropriately receive compensation for the same service within the same time interval at both wholesale and retail levels
- **Operational Compatibility:** There could be instances when wholesale participation and retail obligations conflict with one another

Dual Participation

Opportunity

- Some states and RTOs/ISOs already have retail and wholesale constructs for dual participation while others may need to implement new constructs.
- States will have a key role, as recognized by FERC, particularly as it relates to oversight and design of retail programs. A thorough understanding by all parties of best practices and considerations will facilitate the regulatory decision-making process and pave the way for DER dual participation in a way that appropriately balances the interests of DER owners and aggregators, distribution utilities, and retail customers

Recommendations

- Load forecasting reconstitution practices exist today for wholesale demand response in markets such as NYISO and ISO-NE; other grid operators can leverage these existing practices for DERs
- States should establish a process through which the utility can identify where duplicate compensation may occur and RERRAs should develop appropriate mechanisms to prevent duplicate compensation (e.g., eligibility criteria in the aggregation enrollment and review, including ways to operationalize those criteria)
- Consideration of, and accounting for, instances of dual participation where a DER's capability may be split to provide more than one distinct wholesale or retail service in a given interval

Dual Participation Recommendations

(Continued)

- ISO/RTO participation models for joint ownership may be an example of how dual participation could be structured
- New York utilities' CSRP and DLRP tariffs provide useful models for preventing double compensation of energy
- DER Aggregators should update the DERA's operational status to the ISO/RTO to appropriately reflect any retail activities and/or obligations of DERs that comprise the DERA that impact resource availability for wholesale services and potential dual participation
- Retail tariffs and contracts should have guidelines for governing DER dual participation (such as identifying incompatible wholesale market services), with consideration for both normal and emergency operations at the bulk- and distribution-system levels
- States should proactively collaborate with utilities, DERs, Aggregators, and RTOs/ISOs to develop dual participation rules that are transparent and accommodate DER capabilities while preventing those issues outlined earlier in this document
- States should recognize that on-site metering will be necessary to facilitate wholesale participation and/or participation in retail programs

Appendix A:

Full Dual Participation Section of AEE – GridLab Report

Dual Participation Introduction

Dual Participation Issues Covered

Purpose

- Order No. 2222 requires all RTOs/ISOs to provide aggregated DERs with access to the wholesale markets. FERC defined DERs as any resource located on the distribution system, any subsystem thereof or behind a customer meter. This could allow the same DER aggregation to provide both wholesale and retail services, known as dual participation. Enabling dual participation will require thoughtful construction of both RTO/ISO-level market rules and state-level programs, reasonable oversight, and appropriate compensation for participating resources. This WG sought to identify the potential opportunities and challenges to enable dual participation and develop recommendations with respect to addressing those challenges.

Challenges

- Double Counting: To the extent that a DER's wholesale participation coincides with the LSE/EDC peak demand and that participation impacts the amount of capacity for an ISO or LSE/EDC to procure, the DER's wholesale activities will need to be added back to the peak load to ensure the ISO or LSE/EDC can accurately plan for system peak demand
- Double Compensation: Absent mechanisms to prevent duplicate payments, DERs engaged in dual participation may inappropriately receive compensation for the same service within the same time interval at both wholesale and retail levels
- Operational Compatibility: There could be instances when wholesale participation and retail obligations conflict with one another

Opportunity

- Some states and RTOs/ISOs already have retail and wholesale constructs for dual participation while others may need to implement new constructs. RERRAs will continue to have a key role, as recognized by FERC, particularly as it relates to oversight and design of retail programs. A thorough understanding by all parties of best practices and considerations will facilitate the regulatory decision-making process and pave the way for DER dual participation in a way that appropriately balances the interests of DER owners and aggregators, distribution utilities, and retail customers

Current Landscape

FERC Guidance on Double Counting and Double Compensation

FERC requires RTOs/ISOs to allow DERs to participate in both wholesale and retail programs, but...

- Allows RTOs/ISOs to “limit the participation of resources in RTO/ISO markets … that are receiving compensation for the same services as part of another program” (O2222 P 159)
- FERC requires the ISOs to “include any appropriate restrictions on the DERs’ participation in RTO/ISO markets … if narrowly designed to avoid counting more than once the services provided” (O2222 P 160)

FERC provided guidance on double counting and/or double compensation and allowed restrictions to prevent double counting. Examples include:

- DERs registered to provide the same services either individually or as part of another RTO/ISO market participant, or
- DERs included in a retail program to reduce a utility's or other load serving entity's obligations to purchase services from the RTO/ISO market" (O2222 P 161)

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Current Landscape

FERC Guidance on RERRA Jurisdiction Over Dual Participation

FERC considered the bounds of RERRA jurisdiction over DER wholesale market participation, particularly as it relates to wholesale/retail participation

- "A RERRA cannot broadly prohibit the participation in RTO/ISO markets of all distributed energy resources or of all distributed energy resource aggregators" (O2222 P 58)
- However, "under a RERRA's jurisdiction over its retail programs, such a regulatory authority is able to condition a DER's participation in a retail DER program on that resource not also participating in the RTO/ISO markets" (O2222 P 61)
- This provision "should allow [RERRAs] to mitigate any double-compensation concerns" (O2222 P 162)

Current Landscape

Existing Constructs For Dual Participation

- NYISO's market rules have allowed resources that provide wholesale market services to also provide services to another entity (e.g., the utility or a host facility) since May of 2020. Certain demand response programs have allowed dual participation as early as 2001
- Resources engaged in dual participation are required to:
  - Comply with all NYISO market rules for services offered to the wholesale market
  - Appropriately offer into the wholesale markets to reflect any non-wholesale (e.g., retail) obligations
- Although NYISO needed to ensure that its tariff complied with Order No. 2222, the New York construct can provide instructive examples for thinking about dual participation in other contexts

New York ISO
Independent System Operator

- New York utilities have also developed retail tariffs and programs to dovetail with the NYISO dual participation construct while providing support to its distribution system
  - Examples are shown on the following page

nationalgrid
Orange & Rockland
conEdison
PSEG LONG ISLAND
Central Hudson Gas & Electric Corporation
RG&E
NYSEG

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Current Landscape

Existing Constructs For Dual Participation (continued)

Select New York Retail-Level Programs for DERs as of Fall 2021

Retail Level Program	Overview	Compensation Structure	Is dual participation allowed by utility tariff/contract?
Distribution Load Relief Program (utility tariff)	Compensates DERs for providing relief during distribution-level contingencies. Two-hour notification	Availability payment ($/kW-mo subject to performance) during summer months and per event energy payment	Yes, full wholesale participation allowed, but no energy payments if dispatch overlaps with NYISO dispatch
Commercial System Relief Program (utility tariff)	Compensates DERs for providing relief during utility network/utility system peaks	Availability payment ($/kW-mo subject to performance) during summer months and per event energy payment	Yes, full wholesale participation allowed, but no energy payments if dispatch overlaps with NYISO dispatch
Value of DER (utility tariff)	Compensates injecting DERs for providing different value streams, including distribution relief value, locational system relief value, capacity, energy, and environmental	Based on value stack and performance during value stack hours (e.g., distribution relief value summer weekdays 2-6, capacity during system peak hour)	No, since the value stack includes all wholesale values except ancillary services. Capacity value provided through reduction to utility's wholesale capacity requirements and credited to DER
Non-Wires Solutions (utility bi-lateral contracts)	Utility contracts for non-wires solution for defined periods of time with DER provider	Case-specific	Case-specific: contracts may include details on prohibition of dual participation for certain wholesale products or during certain time periods

Areas of Alignment

To the extent that wholesale and retail services are wholly distinct products, do not pose operational conflicts, and do not result in double compensation, then this would be an allowable form of dual participation

RERRAs will have an important role in regulating dual participation

Constructs for dual participation should ensure that double counting and double compensation do not occur

Constructs for dual participation should ensure that resources can reliably satisfy both retail and wholesale obligations

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Recommendations

Double Counting

Challenge

- Both RTOs/ISOs and LSEs/EDCs may rely on wholesale participating DERs to ensure reliability. Absent mechanisms to prevent entities from including the same capacity in their load and supply forecasts, both sets of entities could rely on the same resource at the same time
  - To the extent that a DER's wholesale participation coincides with the LSE/EDC peak demand and that participation impacts the amount of capacity for an RTO/ISO or LSE/EDC to procure, the DER's wholesale activities will need to be added back to the peak load to ensure the ISO or LSE/EDC can accurately plan for system peak demand

Recommendation

- Load forecasting reconstitution practices exist today for wholesale DR in markets such as NYISO and ISO-NE; other grid operators can leverage these existing practices for DERs

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Recommendations

Double Compensation

Challenge

- Absent mechanisms to prevent duplicate payments, DERs engaged in dual participation could inappropriately receive double compensation for the same service within the same interval at both wholesale and retail levels
  - Ex. 1: There are retail interruptible tariffs that include wholesale capacity revenues as part of the participant's value stream. A DER participating in the retail tariff would receive double compensation if it also sold its capacity as part of a DERA
  - Ex. 2: If the same DER is providing energy during the same interval in response to a DERA's wholesale energy market schedule during an interval where it is providing distribution system support that also compensates for energy, it could be compensated twice for the same kWh during the overlapping dispatch intervals

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Recommendations

Double Compensation
(continued)

Recommendations

- RERRAs should establish a process through which the utility can identify where duplicate compensation may occur and RERRAs should develop appropriate mechanisms to prevent duplicate compensation (e.g., eligibility criteria in the aggregation enrollment and review, including ways to operationalize those criteria)
- Consideration of, and accounting for, instances of dual participation where a DER's capability may be split to provide more than one distinct wholesale or retail service in a given interval
  - ISO/RTO participation models for joint ownership may be an example of how dual participation could be structured
- New York utilities' CSRP and DLRP tariffs provide useful models for preventing double compensation of energy
- Periodic re-review (annually, at minimum) may be necessary to affirm double compensation is not occurring once the DER is operating and engaged in dual participation. If instances of double compensation are found to have occurred, it may be appropriate to implement mechanisms which would correct for the duplicate revenue arising from overcompensation

Recommendations

Operational Compatibility

Challenge

- There could be instances when wholesale participation and retail obligations conflict with one another

Recommendations

- DER Aggregators should update the DERA's operational status to the ISO to appropriately reflect any retail activities and/or obligations of DERs that comprise the DERA that impact resource availability for wholesale services. Therefore, if DERs are dispatched for retail-level purposes, ISOs/RTOs will have visibility and account for this activity
- Retail tariffs and contracts should have guidelines for governing DER dual participation (such as identifying incompatible wholesale market services), with consideration for both normal and emergency operations at the bulk- and distribution-system levels
  - For instance, if a battery storage device is providing a Non-Wires Solution to Distribution Utility for a certain window, the storage should be required to maintain the state of charge necessary to meet its retail-level obligation, and to notify the ISO/RTO that the storage device will not be available for wholesale dispatch in the hours leading up the NWS dispatch (such as via an outage management system, DERA adjustments to wholesale market schedules, or other notification mechanism)

Recommendations

RERRA Roles In Regulating Dual Participation

Context

- The RERRA's role of developing guardrails within retail tariffs and/or contracts to address dual participation is important to facilitate DER access to wholesale markets and to provide all services, at both wholesale and retail levels, for which it is capable
  - RERRAs have the option of precluding DER participation in specific retail tariffs, contracts, or programs if the DER is participating in a DERA*
  - RERRAs have responsibility to regulate the aggregation review process and ensure instances where dual participation is prohibited are enforced
  - RERRAs may offer clarity on the compatibility of retail programs with wholesale participation
  - Additional investments in EDC systems may be required to facilitate dual participation (see Investment Recovery and Cost Causation section for more discussion)

Recommendations

- RERRAs should proactively collaborate with utilities, DERs, Aggregators, and RTOs/ISOs to develop dual participation rules that are transparent and accommodate DER capabilities while preventing those issues outlined earlier in this document
  - For example, RERRAs in states without existing dual participation constructs may consider pilots to test dual participation frameworks
- RERRAs should recognize that on-site metering will be necessary to facilitate wholesale participation and/or participation in retail programs

**Note that as of the time of this writing, the full extent of RERRAs' ability to preclude DER participation is the subject of ongoing dialog at FERC, particularly as it relates to the state opt-out under Order 719. The item denoted here refers more specifically to the language in paragraph 61 of Order 2222*

Additional Considerations and Areas for Future Discussion

Areas Needing Additional Discussion

- Frequently dispatched DERs may be subject to baseline erosion. While this is not unique to dual participation, the provision of both wholesale and retail services could exacerbate this issue
- Measurement and verification considerations related to dual participation will require further discussion, particularly highlighting the need for transparency and consistency of methods for assessing performance in retail and wholesale situations
- Dual participation by DERs in a DERA may introduce additional considerations for LSE's load bids which need to be addressed in a market setting (although this issue extends beyond just dual participation)
- Potential for multiple aggregators to represent a single resource could introduce complexity, particularly in the early stages of implementation

Appendix B: Summary of AEE-GridLab Working Group Recommendations:

Interconnection and Aggregation Review;

Communications, Controls, and Coordination;

Investment Recovery and Cost Causation

Interconnection and Aggregation Review

Problem Statement

There appears to be a need for clarity around what an Aggregation Review process might be (and what, if any relationship it has to other processes)

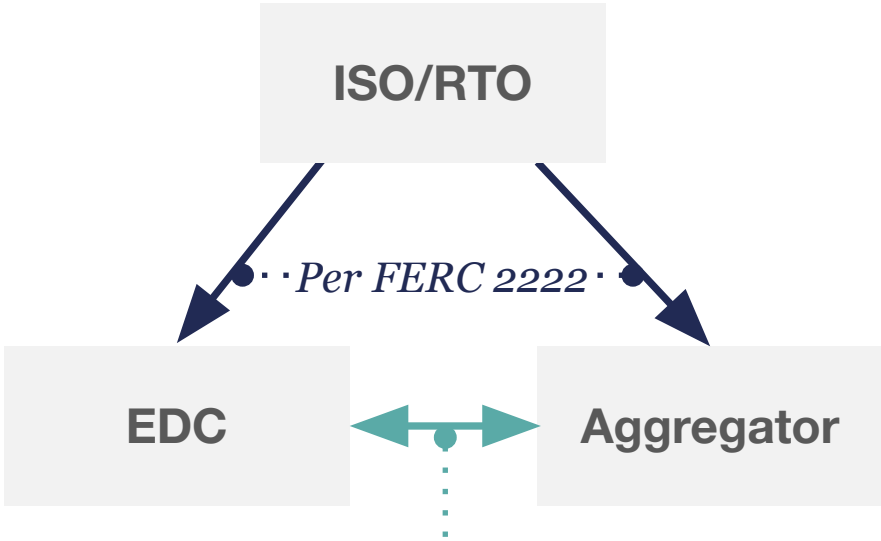
Recommendations

- As EDCs establish an aggregation review process, they should utilize existing data from interconnection or ISO aggregation registration processes where possible to minimize the impact on all parties
- EDCs should work with RERRAs to modify existing distribution interconnection processes to include an option to indicate if a DER is intended to be included in an aggregation
- EDCs should distinguish aggregation review processes for different use cases and penetration levels
- DER aggregators should share ISO/RTO aggregation registration data with EDCs wherever possible and make best efforts to share any updates that take place on a regular basis
- ISO/RTOs should maintain up-to-date records accessible to EDCs on aggregations
- RERRA have an important role to play in approving tariffs, aggregation review processes, relevant cost recovery, adjustments to distribution interconnection, and potentially resolving any disputes that may arise

Interconnection and Aggregation Review Recommendations

(Continued)

- Requirements in the aggregation review process and any necessary impact studies should align with expected dispatch of the aggregation and any restrictions should be transparent for all parties
- Any new/modified processes need to be feasible for EDCs of varying degrees of sophistication
- All parties should expect that these processes will evolve as DER penetrations increase and/or EDC operations become more complex



As determined by RERRA/EDC

Communications, Controls, and Coordination

Problem Statement

FERC order 2222 requires unprecedented coordination between the RTO/ISO, aggregator, and EDC. Existing tools and processes do not provide the functionality needed to enable the required coordination

Recommendations

- Do not assume a complete solution will be implemented immediately; follow a “crawl, walk, run” approach. Start with least regrets deployments
- At the early stage, scrutinize whether additional investments in communications, monitoring and controls above what the RTO/ISO and the interconnection procedures will require are necessary
- Consider if there are simple and lower cost approaches for fostering coordination, controls and visibility between EDCs and aggregators
- The functions of controls and monitoring are distinct, and these terms should not be used synonymously; distinct requirements should be developed.
- Requirements on controls, coordination, and monitoring for various types of DERs can be very different

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Communications, Controls, and Coordination Recommendations (Continued)

- DER installations should leverage autonomous control features that have been adopted as standards, such as IEEE 1547.
- For distribution overrides, there may be two levels of overrides:
  - **Soft override** where aggregator can act based on early notice from EDC
  - **Hard override** where EDC directly curtails or interrupts DER for safety and/or reliability purposes
- The need for hard vs. soft overrides will depend on circumstances and degree of coordination between EDC and aggregator
  - Soft overrides will be the preferred option in non-real time applications and demand response
  - Hard overrides will be a last resort where system reliability or safety is at risk
- Level of automation (i.e., machine-to-machine) vs. manual communication will depend on level of complexity, existing tools at the EDC/aggregator, DER penetrations, and/or grid topology
- Setting clear expectations and open communications between EDCs and aggregators on drivers and likely conditions that lead to distribution overrides will benefit all parties

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Communications, Controls, and Coordination Recommendations

(Continued)

- EDCs alerting aggregators prior to bidding windows and aggregators adapting bidding behavior to expected conditions from EDC could help to alleviate the need for hard overrides
- Support foundational EDC actions that bring greater visibility into the distribution system (such as linking AMI with SCADA and/or ADMS); these can be part of broader grid modernization efforts
- The EDC functions of planning and operations are distinct. Any proposed hardware/software investment should be understood in the context of how they support these distinct functions, and how the EDC plans to institutionalize these new procedures and the feasibility of doing so vis-à-vis current planning and operations
- For small DER applications (especially residential demand response), access to AMI data has been a barrier; consider frameworks that reduce friction for aggregators to access AMI data and/or create systems that don't require aggregators to access AMI data by coordinating the data exchange between the EDC and ISO/RTO
- Low friction aggregator access to relevant meter data for settlement purposes and low friction utility access to relevant metering and controls data for planning, operation and settlement purposes need to be specified and mandated by applicable RTO/ISO tariffs and/or state jurisdictional tariffs in order to scale DERs in wholesale markets

Investment Recovery and Cost Causation

Problem Statement

Implementation of Order No. 2222 will result in incremental distribution level costs

Recommendations

Consider the following potential cost categories when evaluating utility investments that relate to Order No. 2222

1. **Interconnection Studies & Upgrade Costs**
2. **Utility Review of DERA Registration Requests**
3. **Day-to-Day Utility Management of DERs**
4. **Investments to Increase or Maintain Hosting Capacity**
5. **Wholesale Market Access Charge**

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Recommended Considerations by Which to Evaluate Proposed Investments[1]

1. Identify costs required to enable DERs sited on the distribution system to participate in wholesale markets
2. Identify relevant benefits of enabling DER penetration in wholesale markets
3. Avoid duplication of DER benefits in benefit cost analysis
4. Establish an objectively quantifiable basis for measuring, quantifying, and allocating relevant identified benefits and costs
5. Equitably allocate costs between retail customers, DERs, and aggregators, taking into consideration of applicable benefits and consideration of implications of any cost shifts to retail customers

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[1] These principles are focused on costs incurred at the distribution level; costs incurred by RTOs/ISOs are expected to be recovered through existing RTO/ISO cost recovery mechanisms.

BREAK

Return at 2:30PM

Input Session: Grid Services, Interfaces, and Possible Compensation Approaches

Joe Paladino, DOE

NASEO
National Association of State Energy Officials

U.S. DEPARTMENT OF ENERGY
Office of Electricity

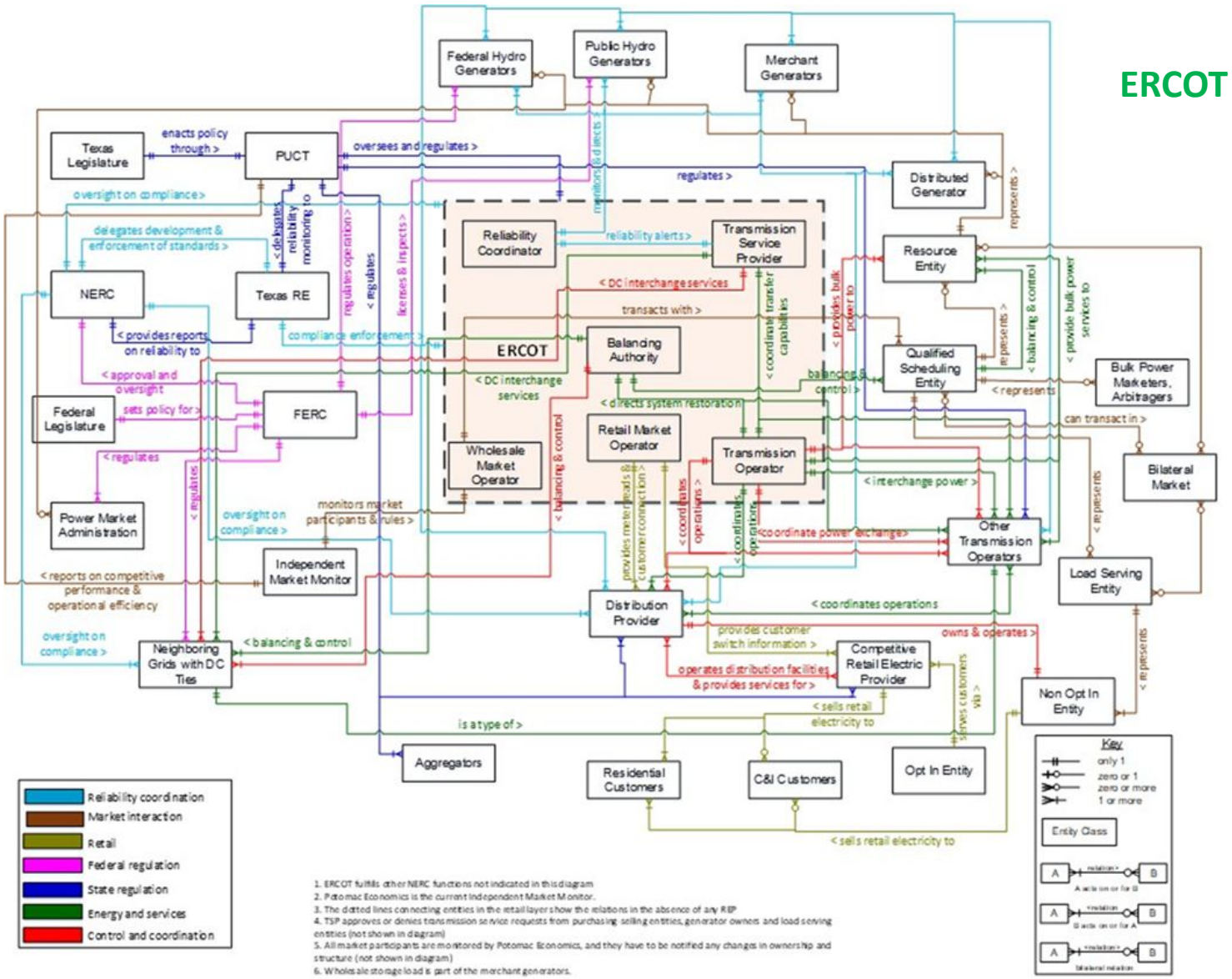
Operational Coordination Considerations

Joe Paladino
Grid Deployment Office
US Department of Energy

NASEO/NARUC I&C Workshop

September 20, 2022

Industry Structure



ERCOT Industry Structure

What are the:

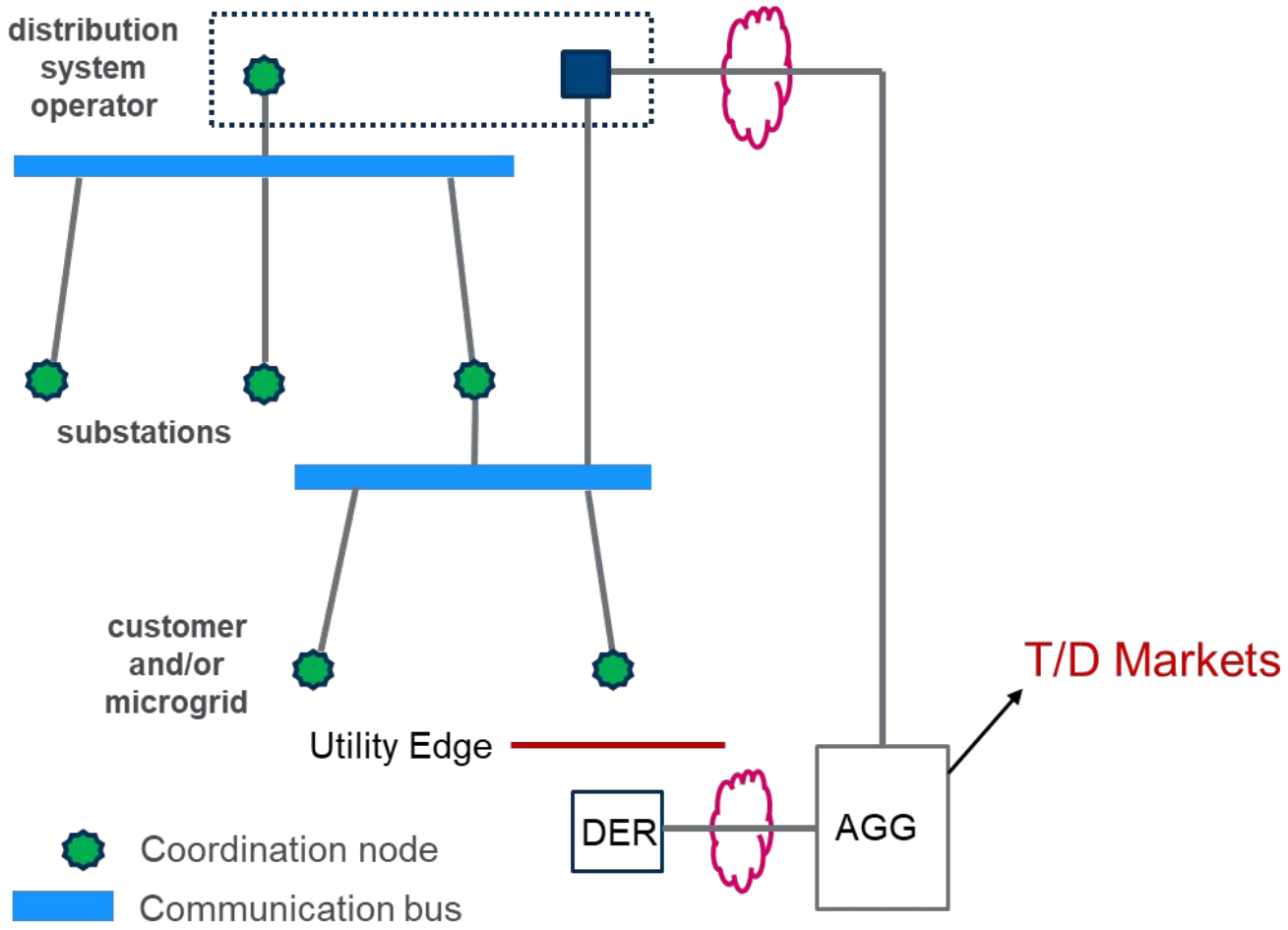
- Respective roles and responsibilities of the participants,
- Data/information sharing requirements, including latency considerations, and
- Sensing, communication, control, and computing requirements to support the above?
- Structural and functional requirements we need to consider?

Diagram produced by Jeffrey Taft, Grid Architect

Coordination and Optimization

The presence of DER not owned by utilities changes the problem from direct control to a combination of control and coordination

- Elements need to coordinate to solve common problems of grid operations (in the presence of DER)
- Each element has performance constraints and optimization objectives
- By examining relationships and interfaces, we can develop coordination frameworks and underlying control and communication requirements
- Laminar coordination allows us to manage an increasing number of nodes
- Proper coordination permits local/system optimization



From JD Taft, Architectural Basis for Highly Distributed Power Grids: Frameworks, Networks, and Grid Codes, PNNL-25480, June 2016

Architecture Coordination Principles

	Considerations	Description
Effectiveness	**Observability**	Function related to operational visibility of the distribution network and integrated DER. Observability needs of DSO and TSO depend on how the coordination framework is specified.
	Scalability	Ability of system's processes and technology design to work well for very large quantities of DER resources. Coordination architecture can enhance or detract from this desired capability.
	Cyber security vulnerability	Reduce cyber vulnerability through architectural structure. Structure can expose grid systems to more or less vulnerability depending on data flow structure, which depends on coordination framework.
	Layered Optimization	Large-scale optimization problems are decomposed into multiple sub-problems at discrete layers of the electric system within a coordinated structure.
Risks	**Tier bypassing**	Creation of information flow or instruction/dispatch/control paths that skip around a tier of the power system hierarchy, thus opening the possibility for creating operational problems. To be avoided.
	Hidden coupling	Two or more controls with partial views of grid state operating separately according to individual goals and constraints; such as simultaneous, but conflicting signals DER from Customer, DSO and TSO. To be avoided.
	Latency cascading	Creation of potentially excessive latencies in information flows due to the cascading of systems and organizations through which the data must flow serially. To be minimized.

Source: J. Taft, Pacific Northwest National Laboratory

T/D/BTM Coordination

Application of architectural principles simplifies operations simplifies operations and enables scaling

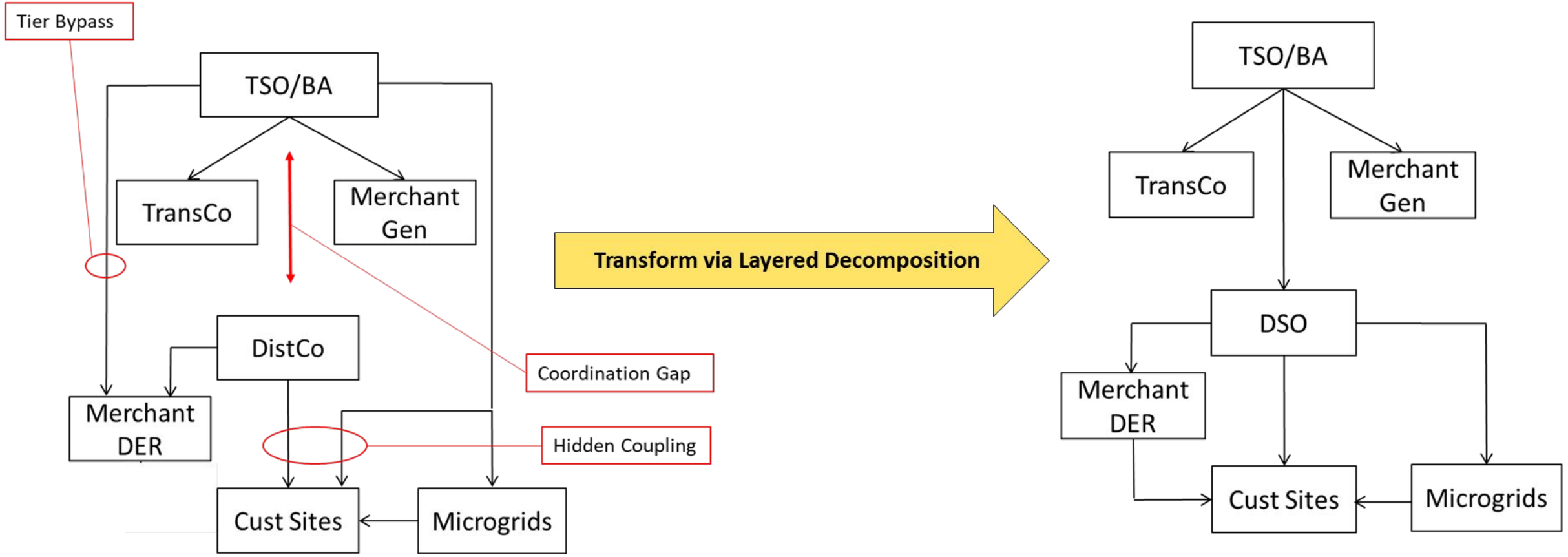
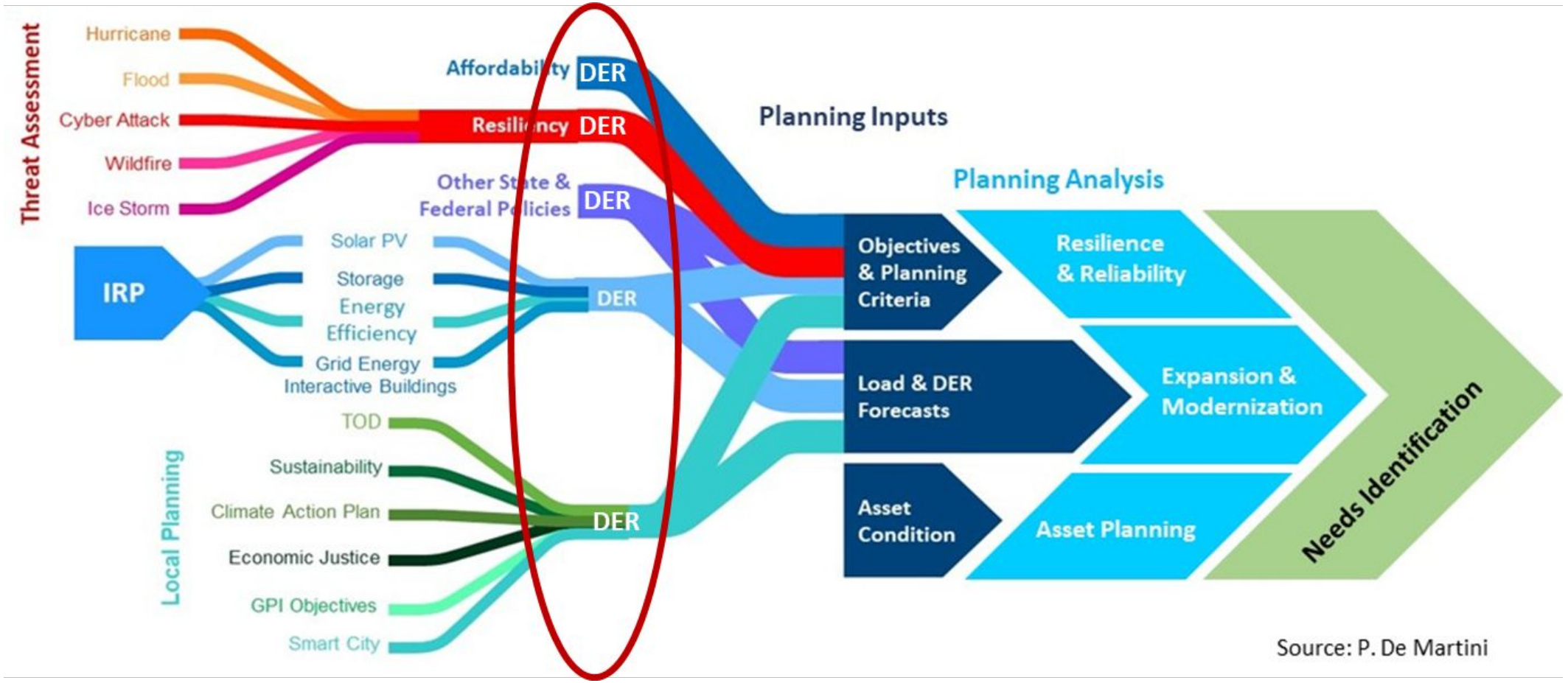


Diagram produced by Jeffrey Taft, Grid Architect

Holistic View of DER Services

Operational Coordination of DER that may provide a range of services at different tiers of the system requires a different paradigm than has been used to-date in the US and globally



Grid Service Mechanisms for DER

It is important to distinguish compensation methods from operating mechanisms when considering operational coordination across the T, D, and BTM domains

Example Only (In Development)	BA Interchange	Bulk System	Bulk -> Dist	Dist -> Bulk	Distribution	Edge - Dist	Microgrid	Edge
Grid Products & Services								
Energy Supply	Price	Phys/Price	Price	Price	Phy/Price	Phy/Price	Phy/Price	Price
Energy Transport	Price	Price	Price	Price	Price	Price	Price	x
Operating Reserves	x	Phys/Price	x	Phys	Price	Phys	x	x
Frequency Regulation	x	Phys/Auto	x	x	?	x	Phys/Price	Phys/Price
Volt/Var Regulation	x	Phys/Auto	x	Phys	Phys/Auto	Phys/Auto	Phys/Auto	Auto
Capacity Deferral	x	Phys/Price	x	Phys	Phys	Phys	x	x
Black Start	x	Phys/Auto	x	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto
Resilience	x	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto

Legend	
Price	Price Formation
Phys	Physical Control
Auto	Parametric Autonomous
x	Not Applicable
	Mature Service in Wide Use
	In Limited Use/Demonstration
	Service under Research

Value Stacking

"Value stacking" will involve various bundles of services for specific applications at different tiers in the system

Virtual Power Plant

- Edge:
  - Autonomous energy supply
- Edge to Distribution:
  - Dispatched load reduction service
  - Autonomous voltage/Var services
- Bulk Power:
  - Dispatched energy supply
  - Dispatched capacity service
  - Dispatched frequency service

Community Microgrid

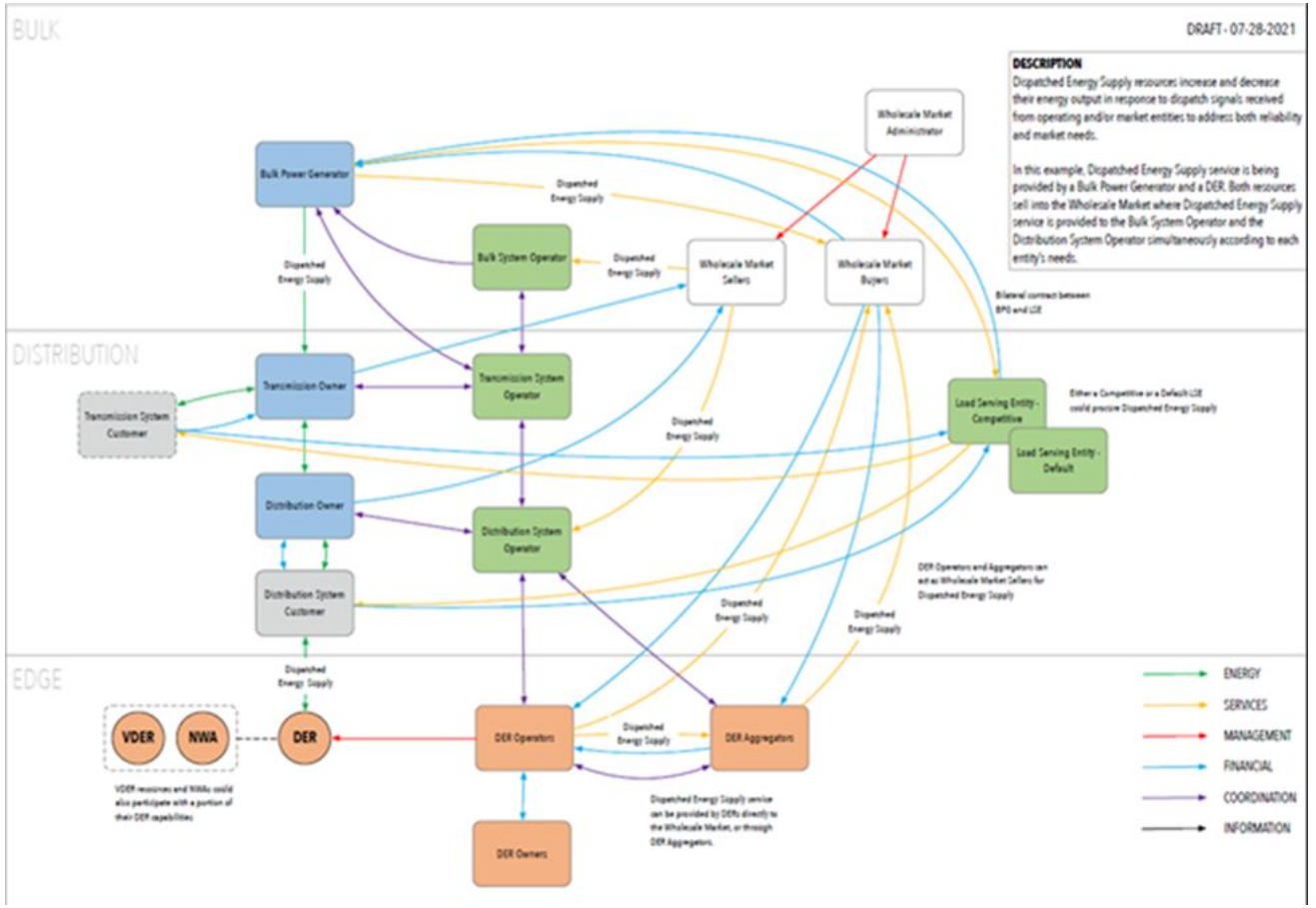
- Edge:
  - Autonomous energy supply
- Edge to Edge:
  - Dispatched energy supply
  - Voltage regulation
  - Resilience service
- Edge to Distribution:
  - Dispatched capacity services
- Bulk Power:
  - Dispatched energy supply

Resolving Structural Issues

At each tier and between each tier there will be different services used with differing operating mechanisms with differing operational time cycles. These need to be evaluated individually and in aggregate to resolve the coordination structure.

Energy Supply Service

- Develop coordination structures for each discrete service associated with each operating mechanism
- Identify actors, information and timing requirements
- Evaluate the resulting “stack” of structures to resolve any conflicts



Architecture Implementation Guide

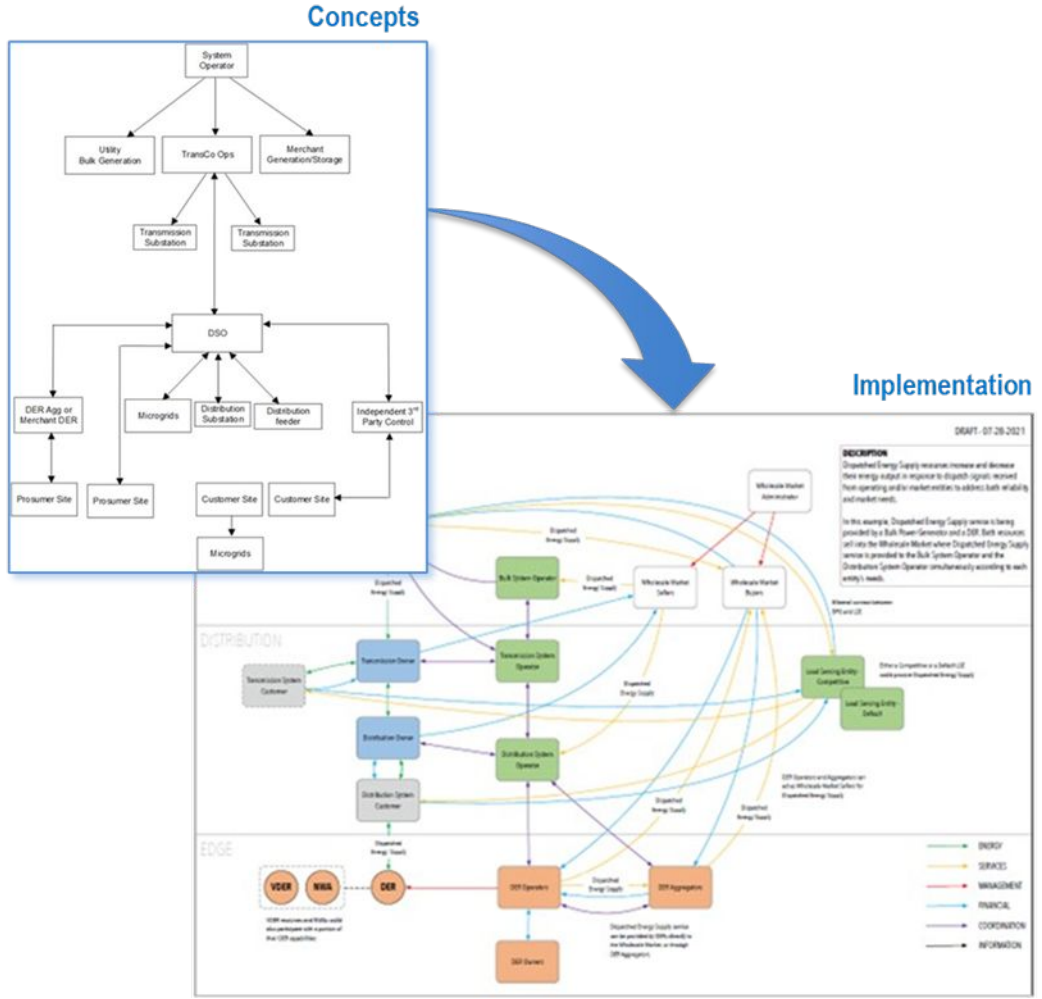
Translating reference grid architecture & principals into practical implementation

Objectives:

- Advance prior grid architectural based methodologies to address operational coordination design, incl. industry structure, markets and operational considerations.

Activities:

- Develop an Operational Coordination Architecture Methodology (OCAM) to guide structural and design considerations and implementations. Addressing need for practical implementation guide incorporating and advancing prior DOE GMLC work.
- Incorporate insights from related international efforts in the UK and Australia.
- Engage industry and state's efforts to address current and expanding future operational coordination needs.



FERC 2222 Compliance Support

Focus on technical assistance for state regulators

Objectives:

- Support states in identifying the range of complexities needing resolution and implementation resulting from RTO/ISO compliance filings to support development of state & distribution utility plans.
- Deliver state technical assistance on topics to support FERC 2222 implementation and develop educational materials on critical topics to expand upon a robust set of existing reference materials.

Activities

Document state considerations related to RTO/ISO compliance filings that delegate significant governance, operational and settlement issues to state regulators.

Engage with NARUC and state regulators in support of their FERC 2222 evaluations and planning.

Catalog existing DOE and industry work to support stakeholder education on critical issues.

Develop a set of holistic distribution grid codes that address grid architectural requirements to support FERC 2222 implementation and enable scale DER adoption and optimization.

Considerations

Utilization of distributed energy resources across the power system requires coordinated policy, regulation, and planning

- What are the DER services anticipated over the next 10+ years at each tier of the power system? (to inform planning)
- What operating mechanisms are appropriate given the operational requirements (e.g., timing) for each service? (market vs control)
- What operational coordination conflicts arise when “stacking” services from the same resource or aggregated resources (e.g., pricing vs direct control vs autonomous vs independent)? (to address structural)
- What level of regulatory coordination & oversight is needed to ensure safe, effective operation across edge to bulk power system? (to address coordination)

Questions

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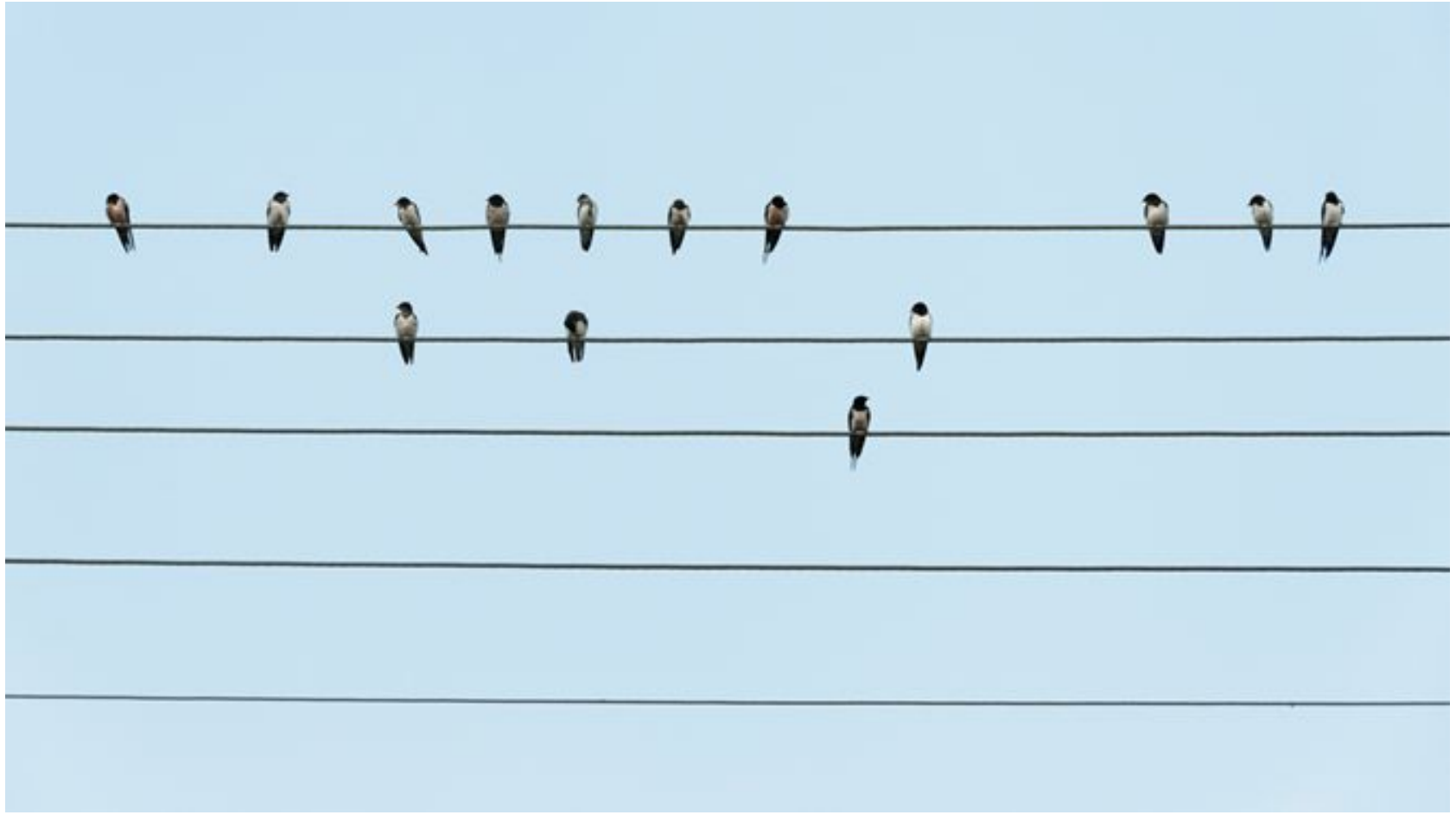


BREAK

Return at 3:45PM

Input Session: Perspectives on RTO/ISO Support Opportunities in Order 2222 Implementation

Paul Spitsen, DOE

National Association of State Energy Officials

U.S. DEPARTMENT OF ENERGY
Office of Electricity

State Feedback on DER Integration into Wholesale Electricity Markets

Paul Spitsen

September 20, 2022

Grid Solutions

Program: a joint EERE-OE-GDO effort to proactively provide end-user-vetted, integrated solutions to cutting edge grid challenges before they become major obstacles for grid deployment

Target Audience: States (governors, legislators, SEOs, PUCs), Local Governments, Tribes, Utilities, ISO/RTOs, FERC, NERC, developers, etc.

Program Philosophy: *Work hand-in-hand* with *institutional innovators and industry leaders* through formal stakeholder engagement mechanisms to identify key issues, jointly develop solutions, disseminate best practices, facilitate peer learning, and *pilot identified solutions with end-users*.

★	**Integrated Distribution System Planning & Design** *Objective*: Align decision-making between policymakers, regulators, utilities, and stakeholders in the formulation of distribution system investment strategies needed to enable a resilient, equitable, and decarbonized grid that can integrate and utilize all forms of DER, market designs and business models	• Translating equity and resilience considerations into planning objectives • Developing a framework to enable multi-objective decision making • Integrated Distribution System Planning Support • End-Use Technology Adoption and Demand Forecasting • Grid Architecture of the Future • DER Integration and Utilization • Transmission, Distribution, & BTM Operational and Market Coordination • Distribution System Investment Cost-Effectiveness Framework	• Integrated multi-objective planning processes developed in FY22 into power sector processes, provide implementation support for stakeholders • Continue developing best practices & increase availability for end-use tech adoption & demand forecasting • DER Integration & Utilization Support via NARUC/NASEO taskforce • T+D+BTM Operational & Market Coordination workshops, standards development, pilots? • Providing support for grid architecture to support future EDS system functionality
	Resource Adequacy *Objective*: Ensure planning paradigms procure an appropriate amount of capacity during all hours of year given evolving weather, system configurations, and technology mixes.	• Best Practices for Resource Adequacy Requirements Given Extreme Weather & an Evolving Grid • Capacity Accreditation • Climate Modeling and Extreme Weather Data Scenario Development • Resource Adequacy Tool & Data Validation • Piloting Innovative Planning Approaches and Decision Support	• **Increasing availability of future weather & hydro data from downscaled GCM results** • Assistance **estimating RA requirements** based on best practices • Pilot innovative individual utility/state as well as **regional RA approaches**
★	**Electricity Markets** *Objective*: Provide foundational research & direct TA to ISO/RTOs to ensure electricity markets adequately represent new technologies, are reliable and resilient, and ensure adequate levels of future investment	• Research Prioritization with ISO/RTOs • Electricity Market Design to Enable System Flexibility and Reliability • Electricity Market Design to Enable Long-term Investments • Enabling DERs to Participate in Wholesale Electricity Markets • Decision Support for Entities Wishing to Join Organized Electricity Markets	• Building on FY22 prioritization continue working with ISO/RTOs to assess flexibility, reliability, and long-term investment challenges. • Consider **deep dives into specific RTOs systems to consider the impact of new market solutions** • **Continue decision support for states wishing to join organized markets**
	Multi-State/Regional Planning *Objective*: Help states, planners, regulators understand the benefits and challenges of planning and operating systems across regions	• Integrating Resilience Objectives into Multi-State Planning • Bulk-Power Interconnection Trends • Methodology to Identify Regional and Interregional Transmission Benefits • High Resolution & High Flexibility Power Sector Modeling and Simulation Tools	• **Assistance to for regional planning exercises**, especially those focused on achieving 100% while maintain reliability & increasing resilience • Support **of quantifying regional & inter-regional transmission benefits**

DER Integration into Wholesale Markets

- DER (demand side flexibility, efficiency, energy storage, distributed generation) adoption is accelerating due to state policies and increased consumer demand.

- In order to decrease adoption costs and maximize DERs ability to enhance reliability and resiliency it's critical to clarify jurisdictional roles and objectives as well as identify optimal market and technical requirements.

- To that end, FERC issued Order 2222 which required the ISO/RTOs to develop rules to allow aggregated DERs to participate in wholesale electricity markets.
  - So far, CAISO, NYISO, ISO-NE, and PJM have submitted fillings. MISO and SPP plan to do so later this year.
  - Currently each ISO/RTO is proposing different market participation regimes, technical requirements, and implementation schedules (e.g. CAISO & NYISO – Q4 2022, PJM – 2026, MISO – 2030)

- Realistically, DER integration into wholesale markets will be incremental with multiple implementation iterations as states, distribution utilities, ISO/RTOs, and aggregators become more comfortable and identify optimal roles and requirements.

Focus for Today

- Identify and understand potential barriers at the intersection of state, distribution utility, aggregator, and ISO/RTO decision making that could impede or lead to suboptimal use of DERs. Are there ways to avoid potential challenges?

- Some of potential barriers could be related to:
  - Roles & Responsibilities
  - Interconnection & Aggregation Requirements
  - Market Participation, Metering, Data, and Telemetry Requirements
  - Others?

- Identify how DOE can develop data, tools, and analysis as well as work directly with states, ISO/RTOs, and others to minimize DER integration barriers, accelerate adoption, minimize cost, and maximize reliability and resilience benefits.

Roles & Responsibilities

- What is the best way to coordinate between the regional grid operator, the DER aggregator, the distribution utility and the relevant retail regulatory authority? How can enhanced coordination accelerate DER deployment and integration.

- Who gets to determine scale and timing of aggregated DER dispatch, and whether dispatch is optimized around distribution or bulk-system needs?

- How do expectations about the ability to deploy and operate DERs impact distribution, bulk-side, and regional planning?

- Are there any other key role & responsibility issues related to DER participation in wholesale markets that are critical to address?

Interconnection & Aggregation

- Which entities should drive interconnection requirements, states/utilities or the ISOs? E.g., ISO-NE just relinquished DER interconnection review to a state-run process to accelerate adoption.

- Should aggregation have a geographic limit? If so, should that geographic limit be determined by a resource (DR vs. DPV/ES) or service type? E.g., nodal constraint for energy vs regional for capacity?

- How should resources be aggregated? E.g., should aggregations be classified by a homogenous use-case or resource type, or should they be allowed to be heterogenous (mix of demand side flexibility and DR gen/storage) able to provide multiple service types as needed?

- Are there any other key interconnection and aggregation issues related issues related to DER participation in wholesale markets that are critical to address?

Market Participation, Metering, Data, and Telemetry

- When is it appropriate to require real-time metered data and when is appropriate to use estimated assumptions? How do these requirements potentially change by aggregation type and size?

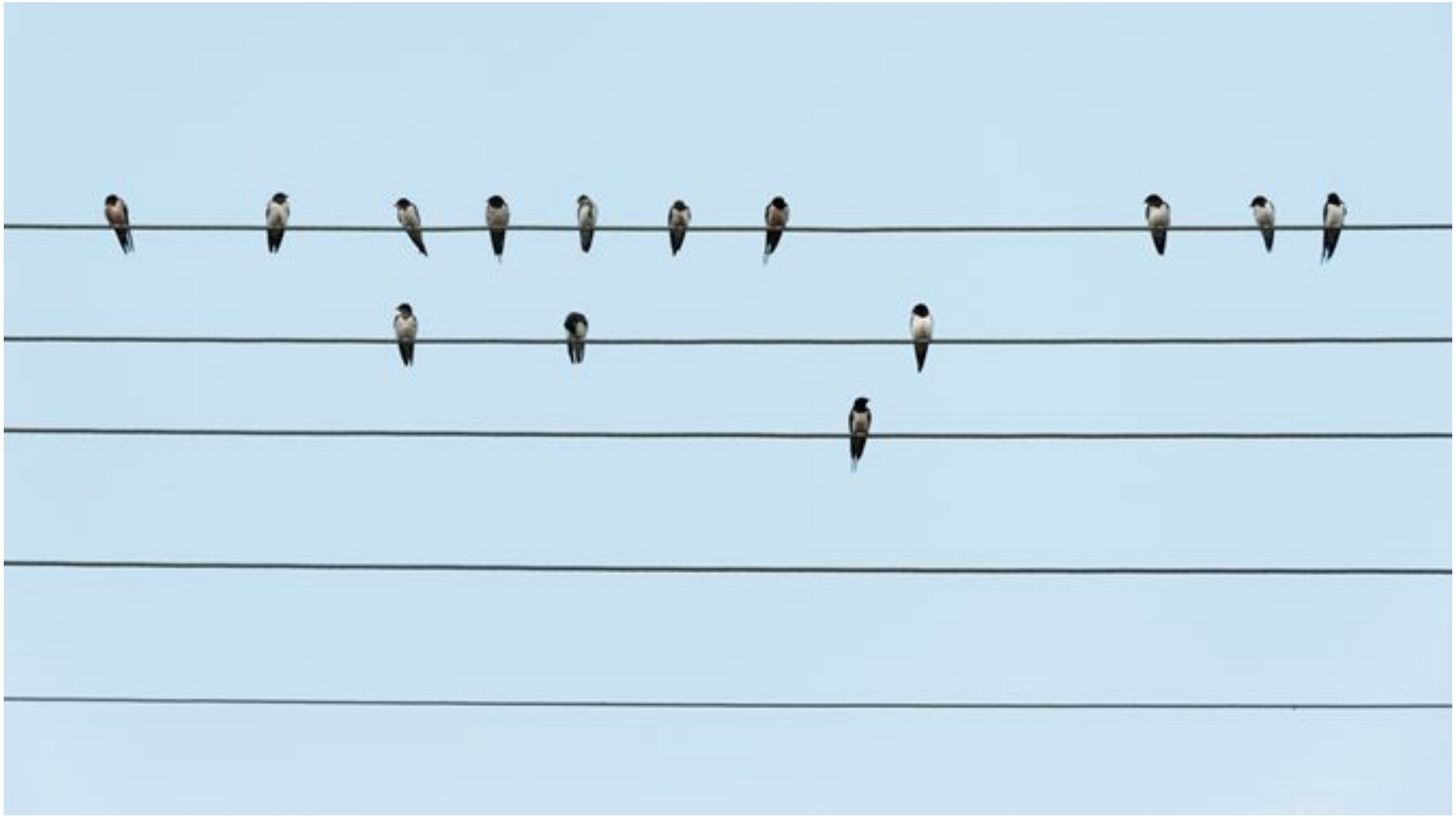
- Are the metering and data requirements well understood to enable the visibility/performance required for participation (esp. for data intensive services like A/S)? Do all actors have access to the necessary data at the right level of resolution?

- Is there adequate information about the cost-effectiveness of different metering and telemetry solutions? How does cost-effectiveness vary by scale? Who pays for what?

- How to ensure compensation is appropriate, prioritized, and avoids double counting? E.g., how to layer net-energy metering with wholesale participation?

- Are there any other key market participation or metering related issues related to DER participation in wholesale markets that are critical to address?

Questions



WRAP UP & FEEDBACK

See you tomorrow!

BREAKFAST: 8:00AM – 8:45AM
WELCOME AND INTRODUCTIONS: 8:45AM – 9:00AM

National Association of State Energy Officials

Thank you for attending!

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