Adoption of IEEE 1547-2018 and Interconnection Procedures

NARUC Electric Committee

Sunday February 9th , 2020

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

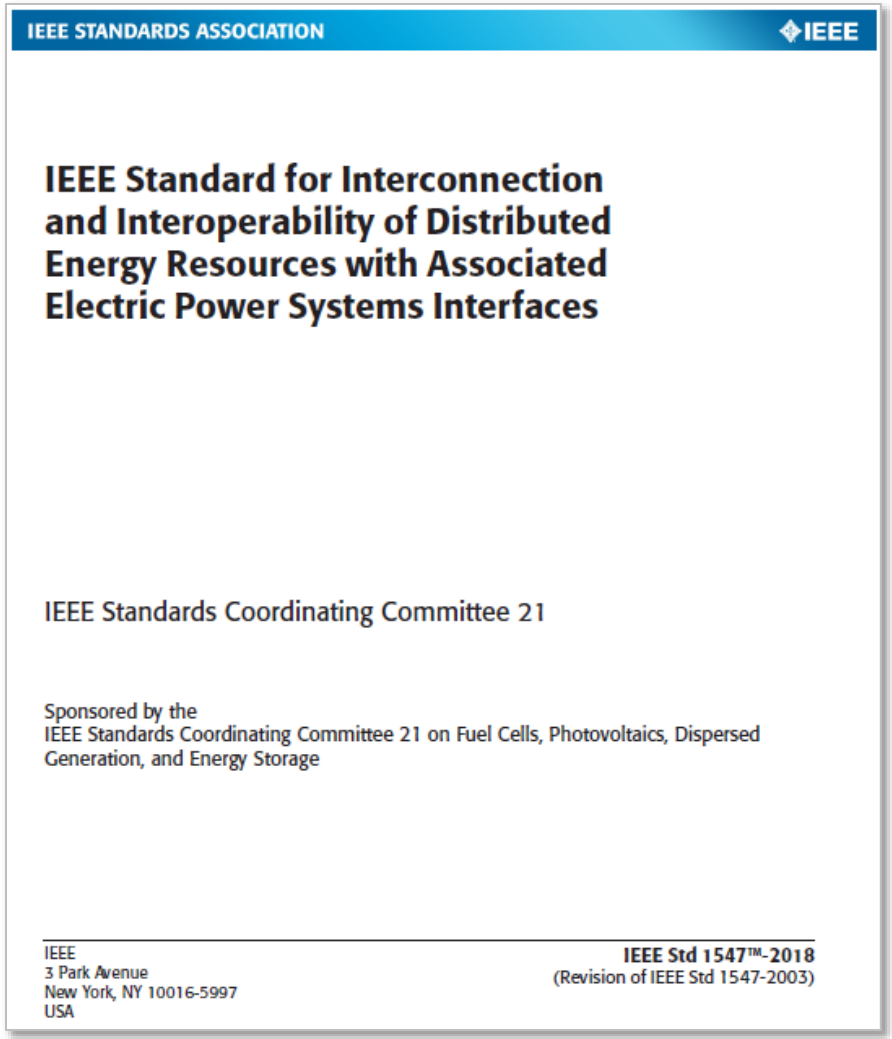
BPS Reliability Perspectives on the Adoption of IEEE 1547-2018

Ryan D. Quint, PhD, PE
Senior Manager, NERC
NARUC 2020 Winter Policy Summit
February 2020

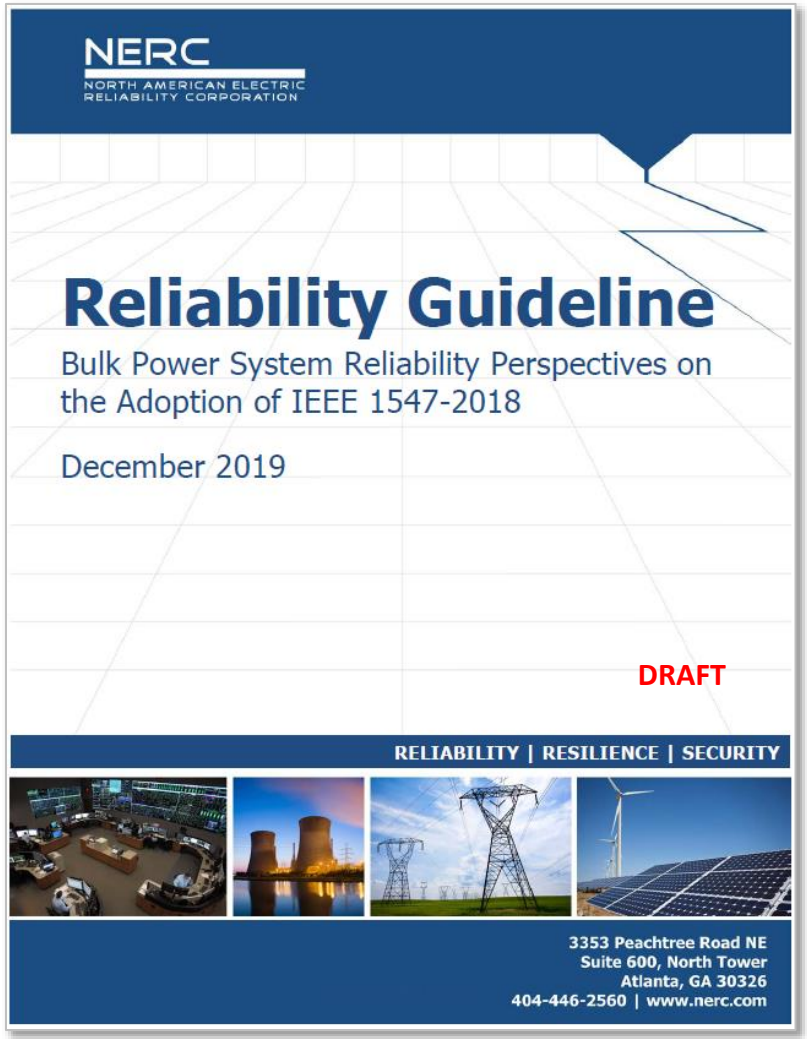
RELIABILITY | RESILIENCE | SECURITY



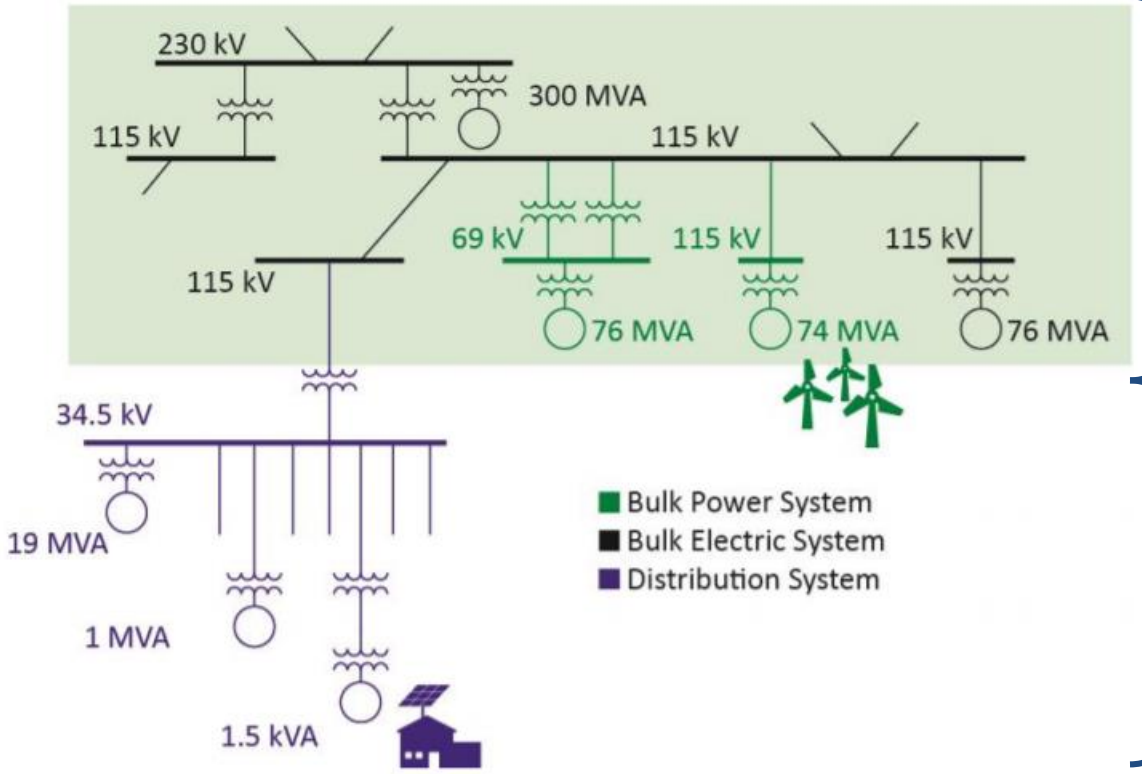

NERC SPIDERWG Guideline



Source: IEEE SA



BES vs. BPS vs. Distribution



IEEE P2800

- Inverter-based resources
- Covers all BPS and BES
  - Transmission-level
  - Subtransmission-level

IEEE 1547-2018

- All power-producing resources
- Distribution-level

Key Takeaways

- ***Aggregate*** amounts of DER can and will impact the BPS
  - NERC Goal: provide support where needed in this area; ensure BPS reliability
- Adoption of IEEE 1547-2018
  - Encouraged, from BPS perspective
  - Coordination led by AGIRs (e.g., States), engagement from RCs
- Educational materials abound
  - NERC SPIDERWG, NERC Reliability Guideline, EPRI reports, etc.
- Coordination necessary for successful IEEE 1547-2018 implementation (BPS perspectives needed in some areas)

• DER Category Selection	• Phase Angle Change Ride-Through
• Voltage Tripping	• Enter and Return to Service
• Voltage Ride-Through	• Unintentional Islanding
• Frequency Tripping	• Intentional Islanding
• Frequency Ride-Through	• Interoperability
• Restore Output	
• Frequency-Droop	

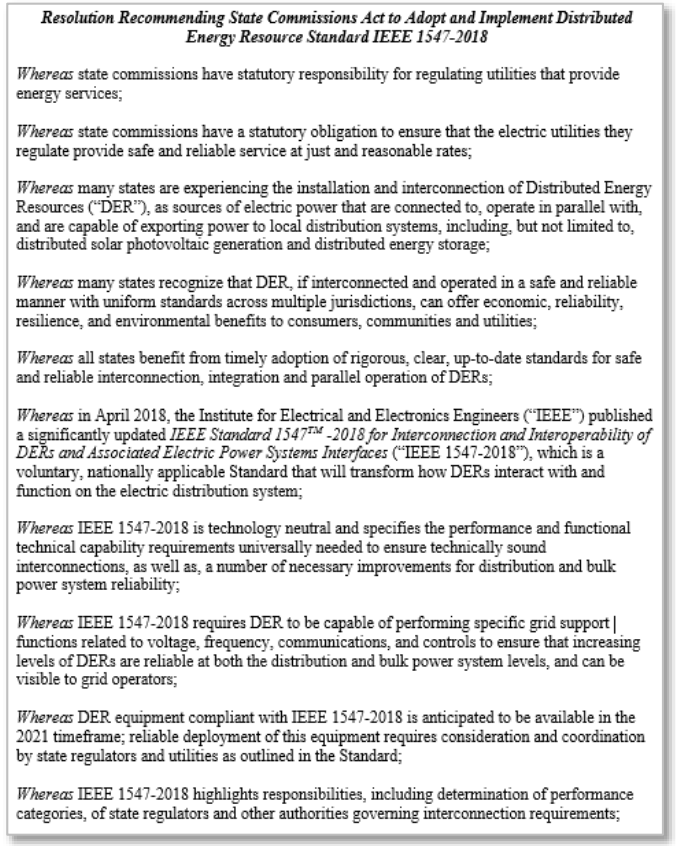
NERC References

- NERC Reliability and Security Guidelines: https://www.nerc.com/comm/Pages/Reliability-and-Security-Guidelines.aspx
- NERC SPIDERWG Webpage: https://www.nerc.com/comm/PC/Pages/System-Planning-Impacts-from-Distributed-Energy-Resources-Subcommittee-(SPIDERWG).aspx
  - *State commission working-level staff encouraged to participate*
    - *Great discussion and good opportunity for education*

Question for Consideration

- ***Question:*** *If you could make one ask of Commissions related to adoption of IEEE 1547-2018, what would it be and why?*

- **My Answer:** "Consider the Future"
  - High DER penetration possible (maybe likely)
  - DER accounting will be critical ("where is it?")
  - Demarcate DER vs. BPS-connected (including subtransmission)
  - Understand ongoing DER impacts
    - SPIDERWG, EPRI, UK disturbance, etc.
  - Retroactive upgrades costly (e.g., Germany)
  - New capabilities add benefits for BPS reliability



Resolution Recommending State Commissions Act to Adopt and Implement Distributed Energy Resource Standard IEEE 1547-2018

Whereas state commissions have statutory responsibility for regulating utilities that provide energy services;

Whereas state commissions have a statutory obligation to ensure that the electric utilities they regulate provide safe and reliable service at just and reasonable rates;

Whereas many states are experiencing the installation and interconnection of Distributed Energy Resources ("DER"), as sources of electric power that are connected to, operate in parallel with, and are capable of exporting power to local distribution systems, including, but not limited to, distributed solar photovoltaic generation and distributed energy storage;

Whereas many states recognize that DER, if interconnected and operated in a safe and reliable manner with uniform standards across multiple jurisdictions, can offer economic, reliability, resilience, and environmental benefits to consumers, communities and utilities;

Whereas all states benefit from timely adoption of rigorous, clear, up-to-date standards for safe and reliable interconnection, integration and parallel operation of DERs;

Whereas in April 2018, the Institute for Electrical and Electronics Engineers ("IEEE") published a significantly updated *IEEE Standard 1547™ -2018 for Interconnection and Interoperability of DERs and Associated Electric Power Systems Interfaces* ("IEEE 1547-2018"), which is a voluntary, nationally applicable Standard that will transform how DERs interact with and function on the electric distribution system;

Whereas IEEE 1547-2018 is technology neutral and specifies the performance and functional technical capability requirements universally needed to ensure technically sound interconnections, as well as, a number of necessary improvements for distribution and bulk power system reliability;

Whereas IEEE 1547-2018 requires DER to be capable of performing specific grid support functions related to voltage, frequency, communications, and controls to ensure that increasing levels of DERs are reliable at both the distribution and bulk power system levels, and can be visible to grid operators;

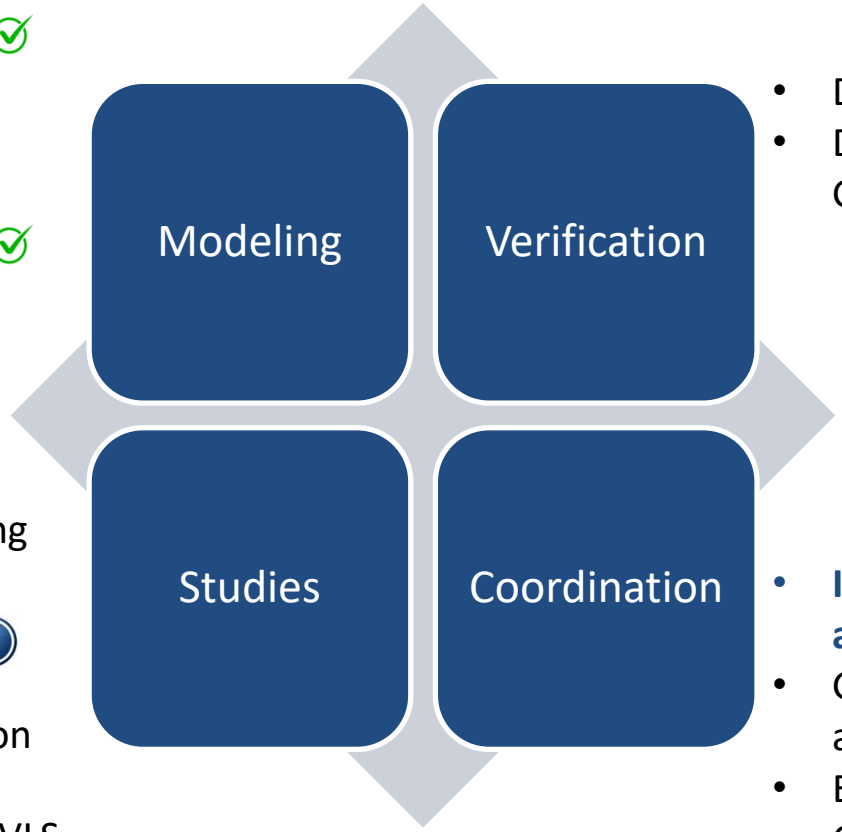
Whereas DER equipment compliant with IEEE 1547-2018 is anticipated to be available in the 2021 timeframe; reliable deployment of this equipment requires consideration and coordination by state regulators and utilities as outlined in the Standard;

Whereas IEEE 1547-2018 highlights responsibilities, including determination of performance categories, of state regulators and other authorities governing interconnection requirements;

Questions and Answers

SPIDERWG

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



- DER Verification Guideline
- DER Forecasting Practices Guideline

- Guideline on BPS Planning Practices with DER
- **White Paper: TPL-001 Standard Review**
- Recommended Simulation Improvements
- Guidance on UFLS and UVLS
- White Paper: Beyond Positive Sequence

- **IEEE Std. 1547-2018 Review and BPS Recommendations**
- Guideline on Communicating across T-D Interface
- Education Materials
- Coordination of Terminology
- NERC Standards Review
- Tracking DER Growth

DER Integration with IEEE 1547 Standards

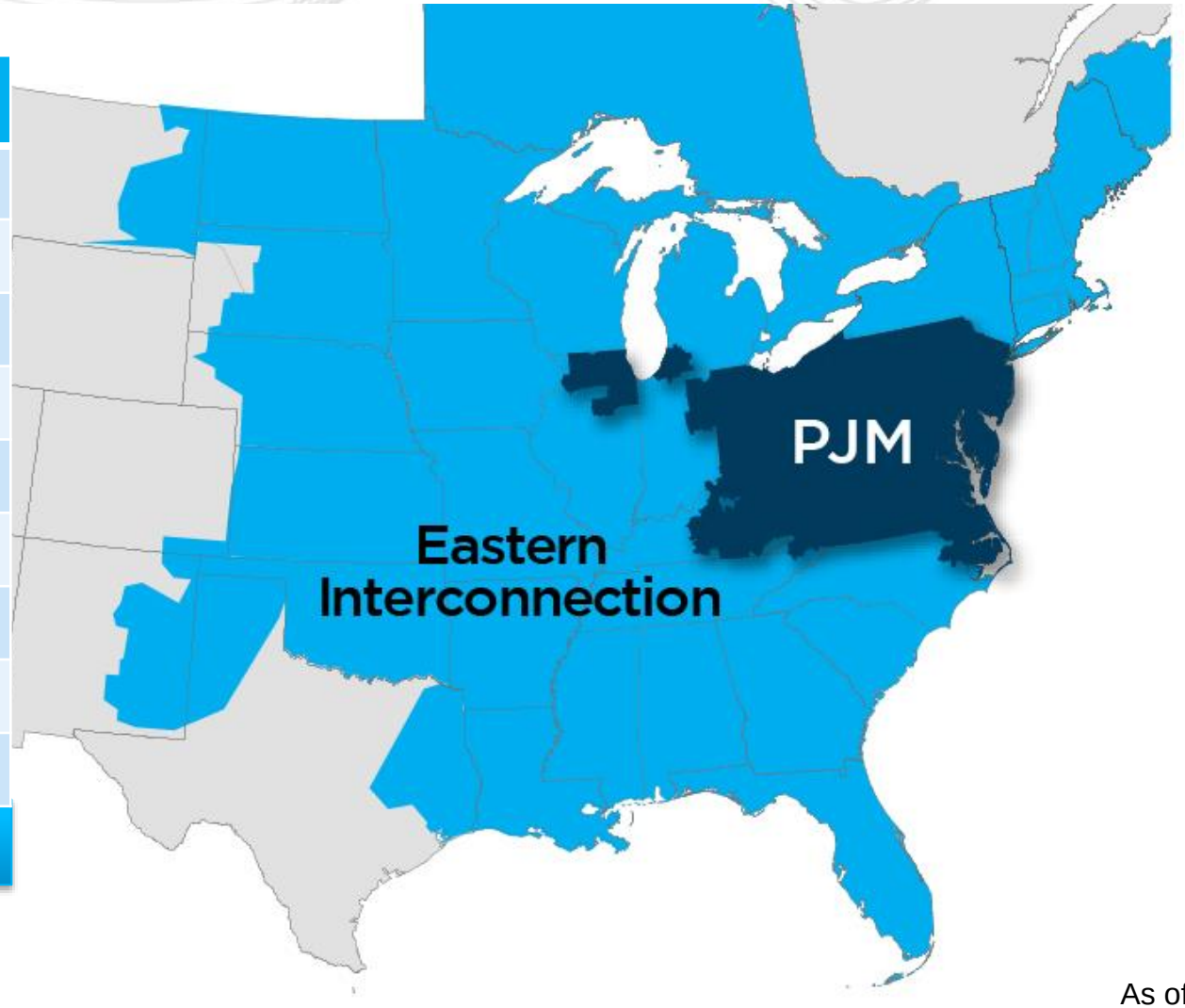
Jay Liu, Ph.D.
Sr. Lead Engineer
Infrastructure Coordination
PJM Interconnection

IEEE 1547 Panel, NARUC
February 9th, 2020

PJM as Part of the Eastern Interconnection

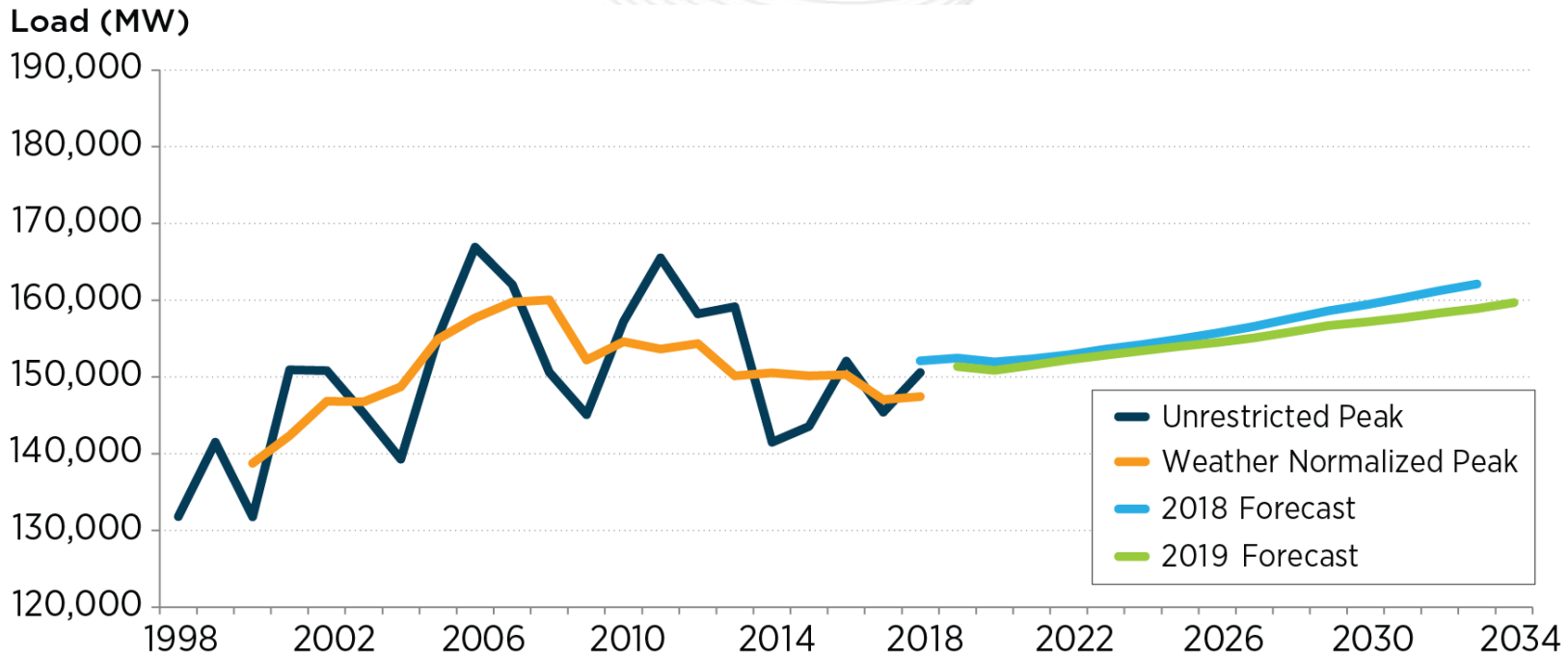
Key Statistics	
Member companies	1,010+
Millions of people served	65
Peak load in megawatts	165,492
MW of generating capacity	180,086
Miles of transmission lines	84,236
2018 GWh of annual energy	806,546
Generation sources	1,379
Square miles of territory	369,089
States served	13 + DC

21% of U.S. GDP produced in PJM



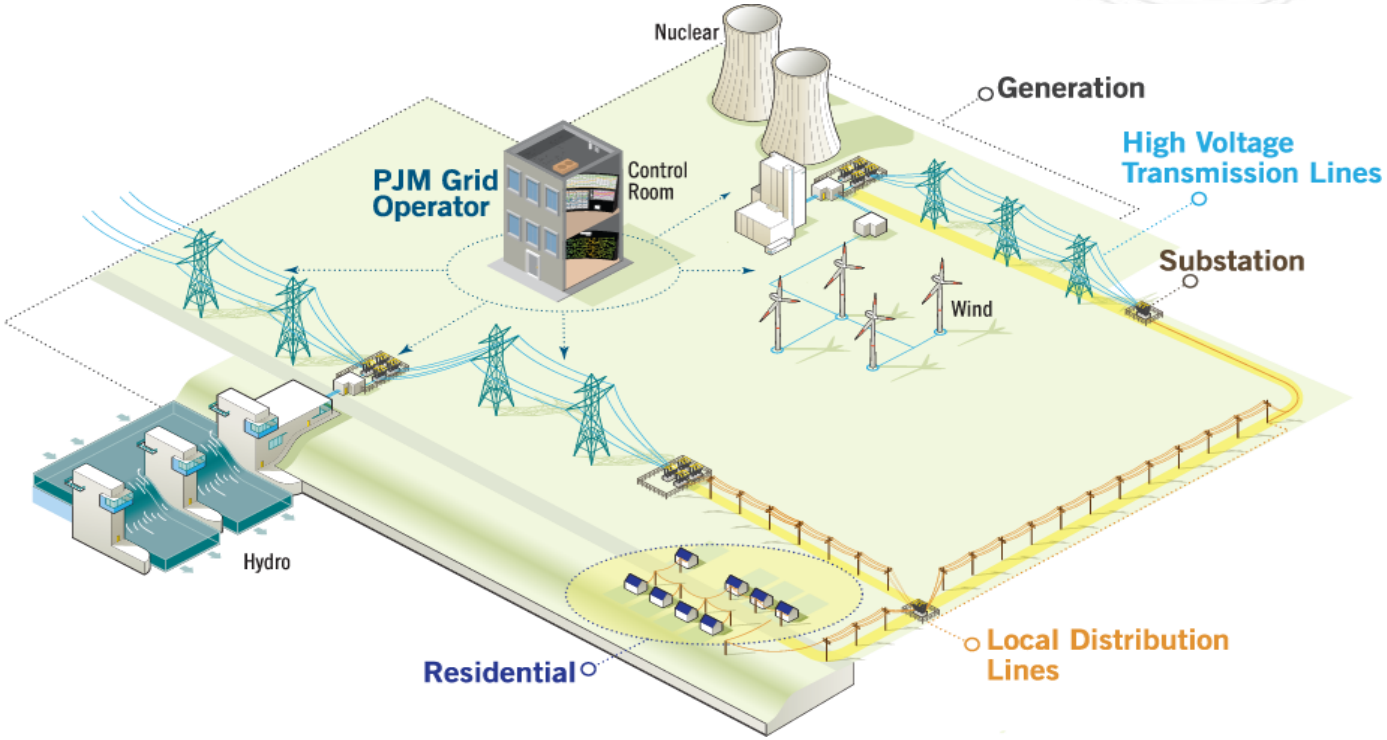
As of 1/2019

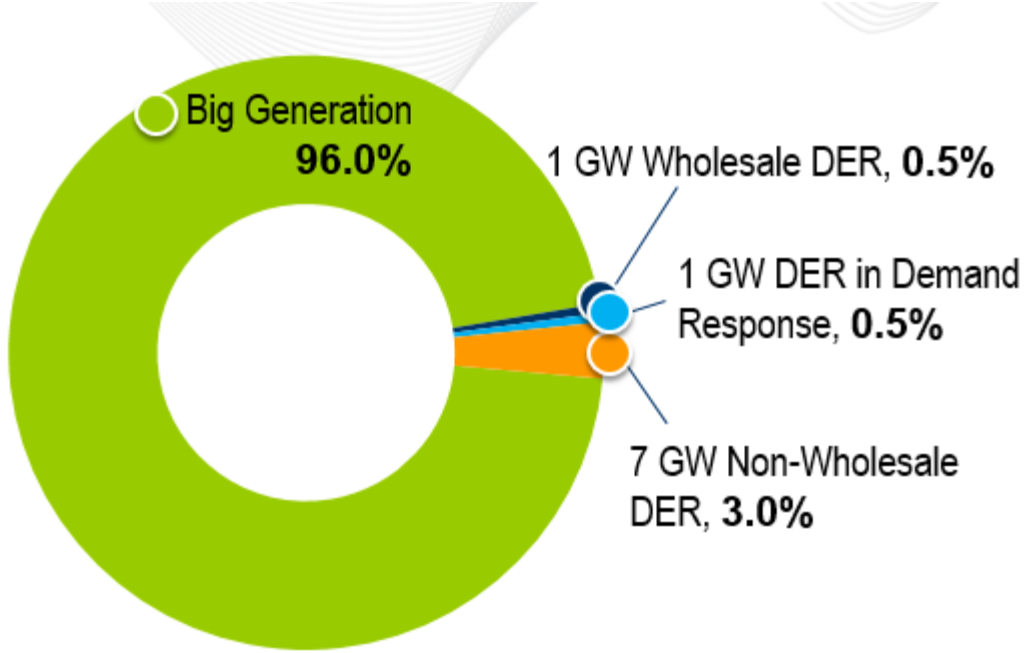
Summer Peak Demand for PJM RTO



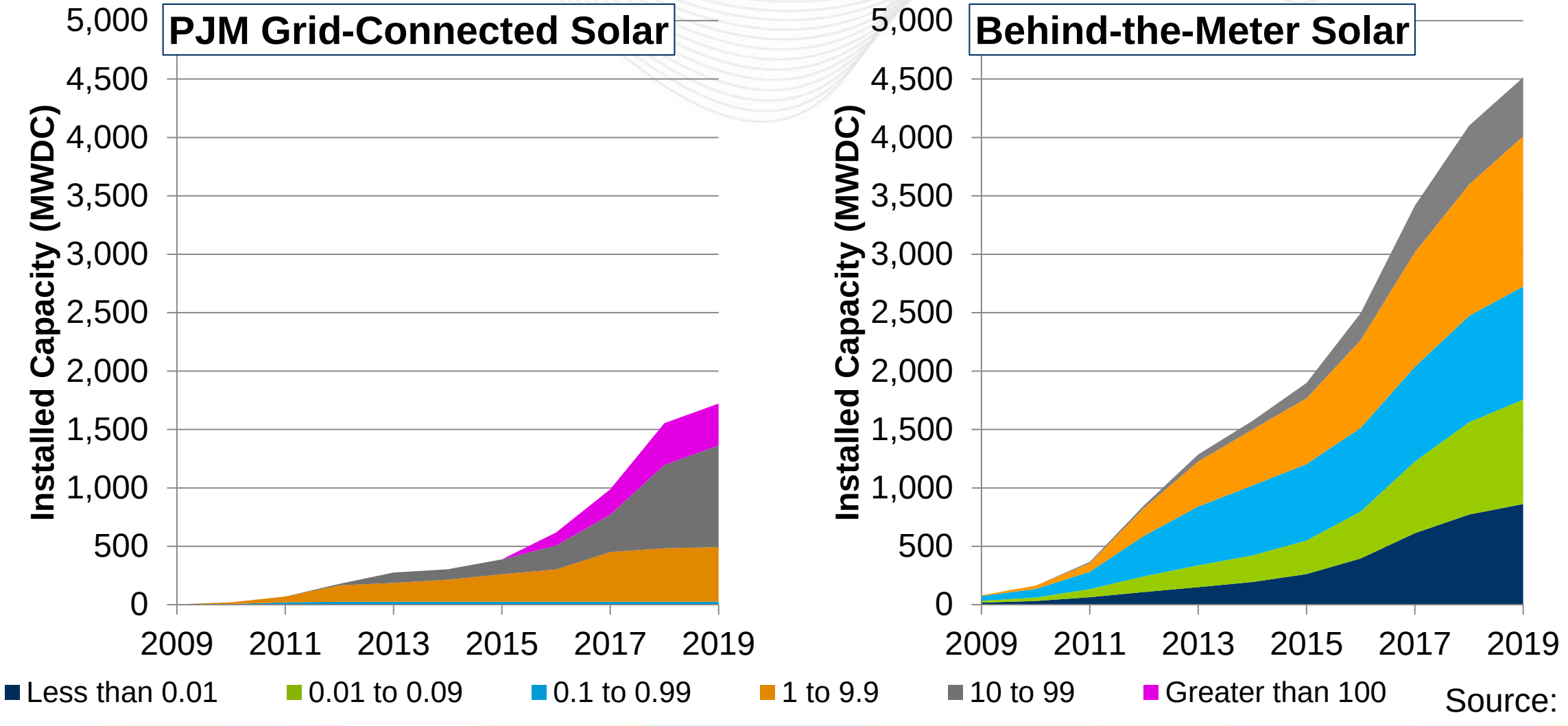
References:
2019 PJM Technical Workshop on DER Integration https://www.pjm.com/committees-and-groups/closed-groups/derrttf.aspx

The Distribution of Power





Ten Years of Renewable Growth in PJM



Source: GATS

Snapshot of DER in PJM Today

Wholesale DER

1 GW Demand Response

Customer-sited generation:
Offers into capacity, energy and/or ancillary services markets

74% **Diesel**	24% **Natural Gas**	2% **Other**

Remaining ~8 GW of DR is load modification without any generation (e.g., industrial process management)

~2 GW Generator

Front-of-the-meter generation:
Offers into capacity, energy and/or ancillary services markets

Can be sited at customers.

Mostly solar but also other fuels

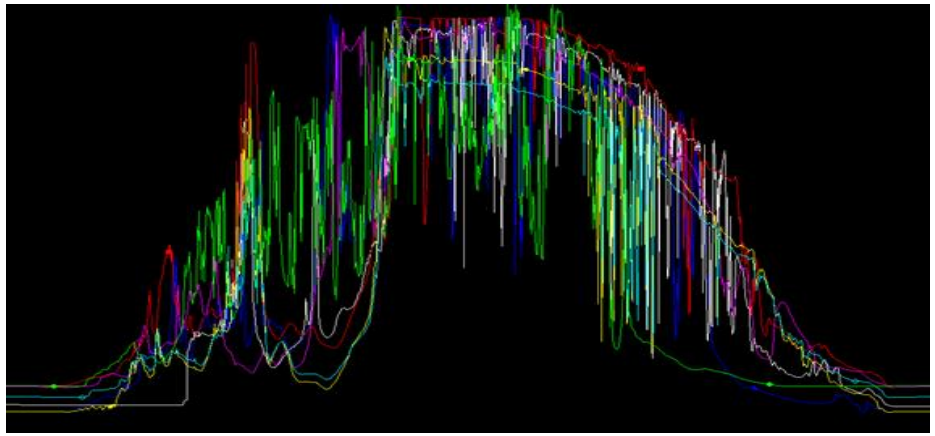
Non-Wholesale DER

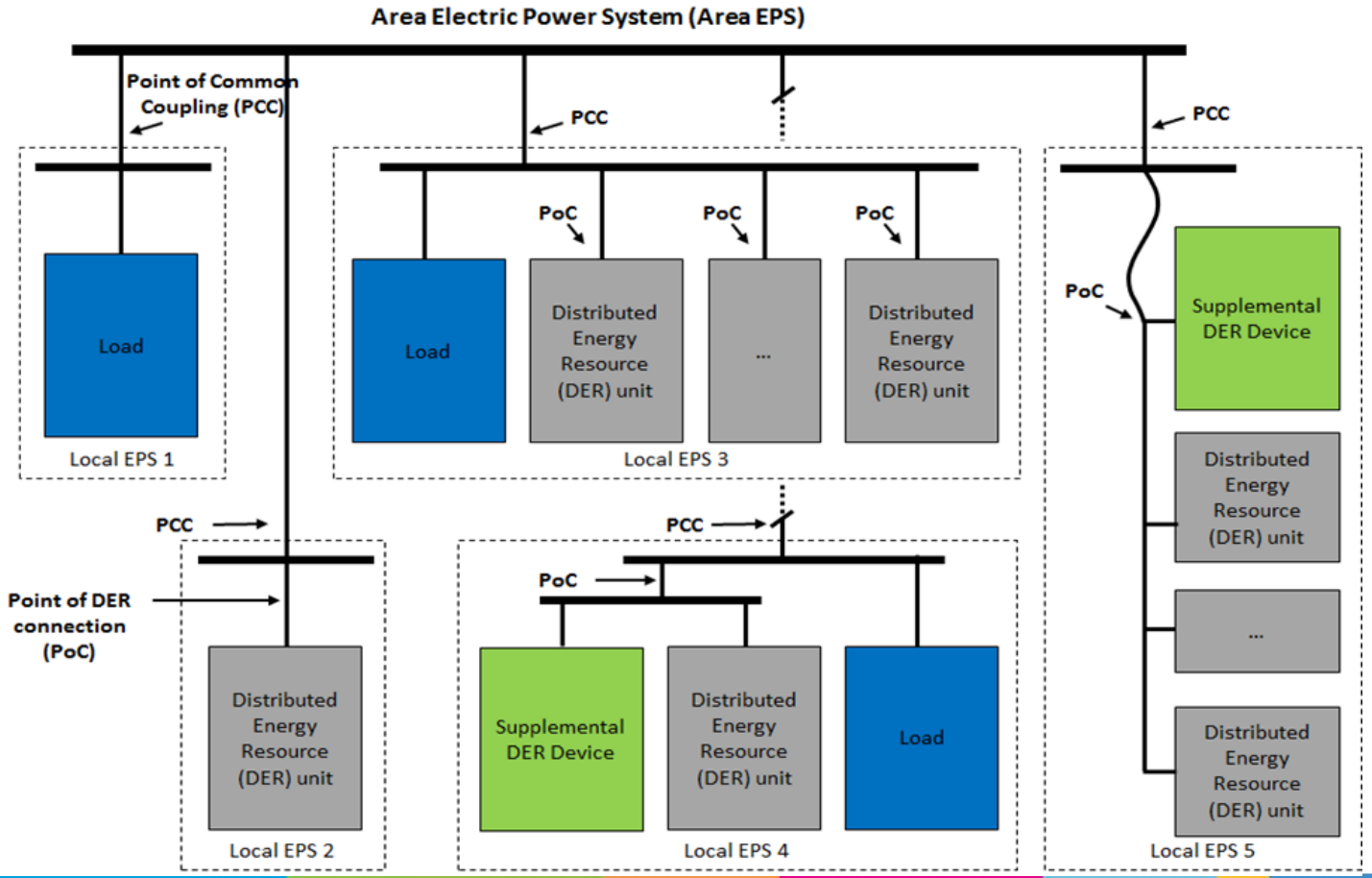
~7 GW DER

- **Solar PV DER:** Retail/rooftop solar
- **Municipal DER:** Municipal electric company distribution-level generators
- **Process DER:** Industrial generators, combined heat and power
- **Resilience DER:** Emergency backup
- **Qualified Facilities:** Direct sales to distribution utilities

DER Integration with IEEE 1547 Standards

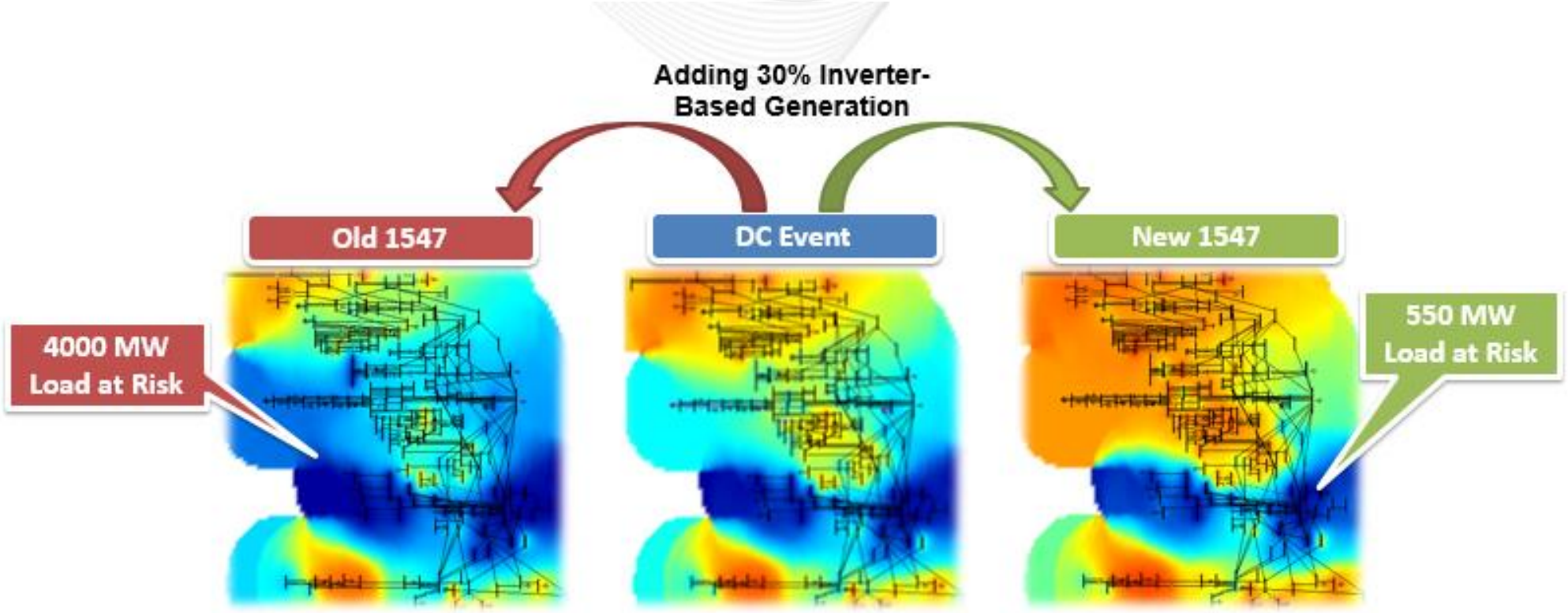
- Interoperability is the key of DER integration





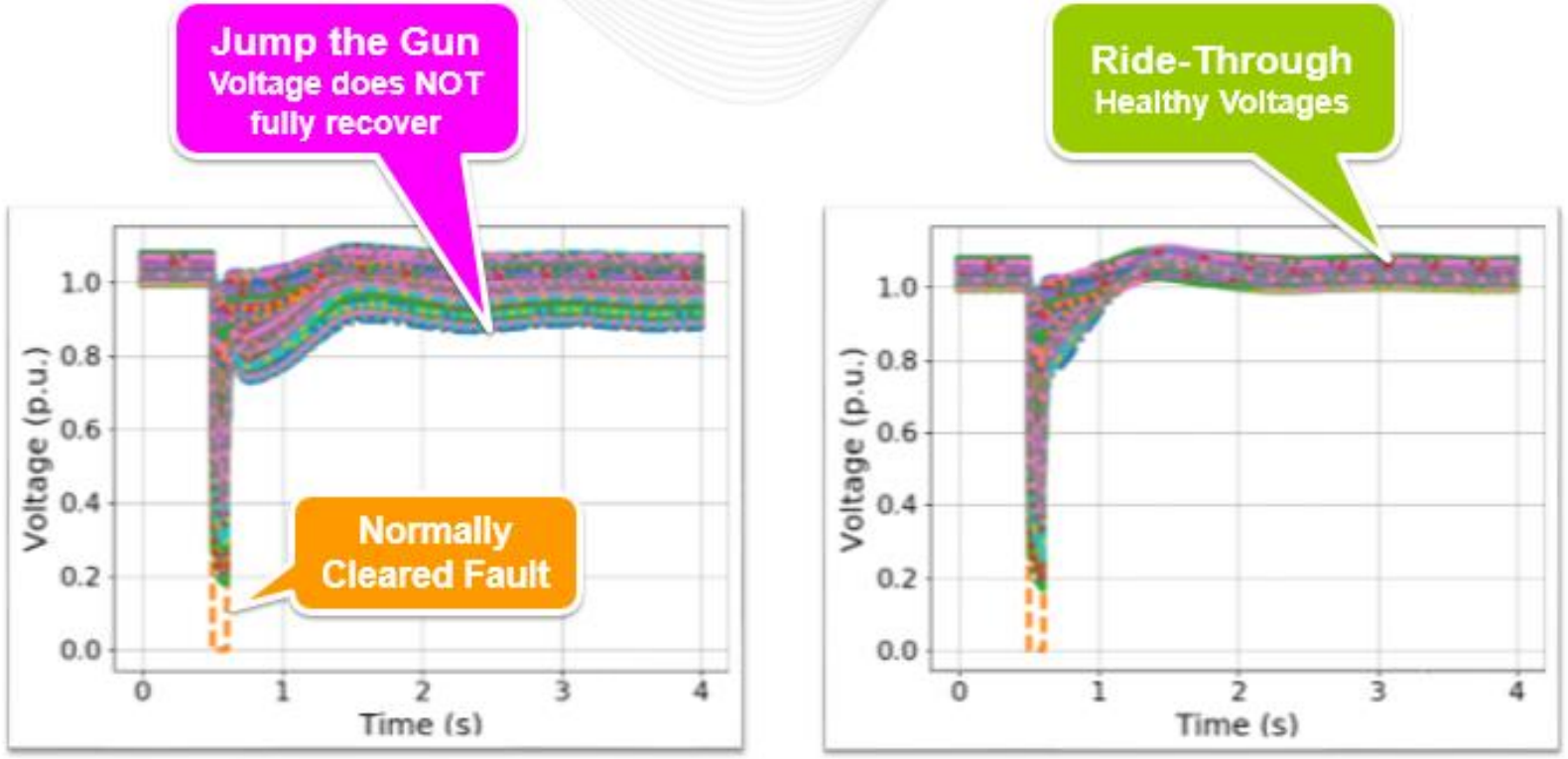
DER Integration with IEEE 1547 Standards

- Improve power grid reliability and resiliency



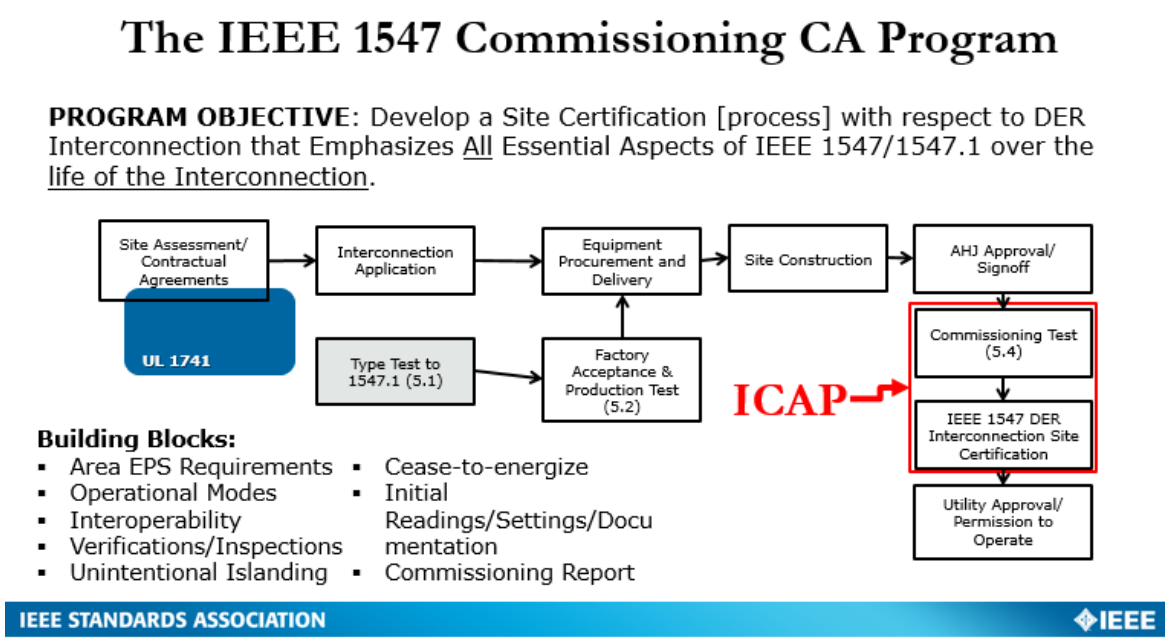
DER Integration with IEEE 1547 Standards

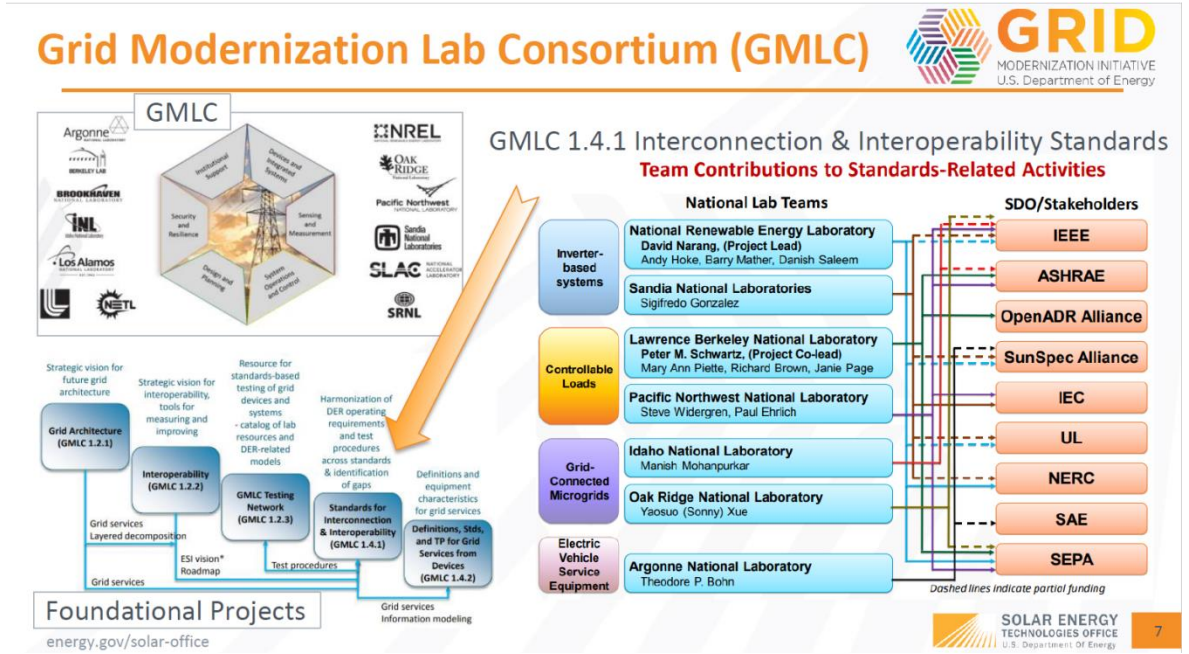
- Ride-Through is a MUST HAVE!



DER Integration with IEEE 1547 Standards

- DER commissioning and life-cycle compliance with technical standards





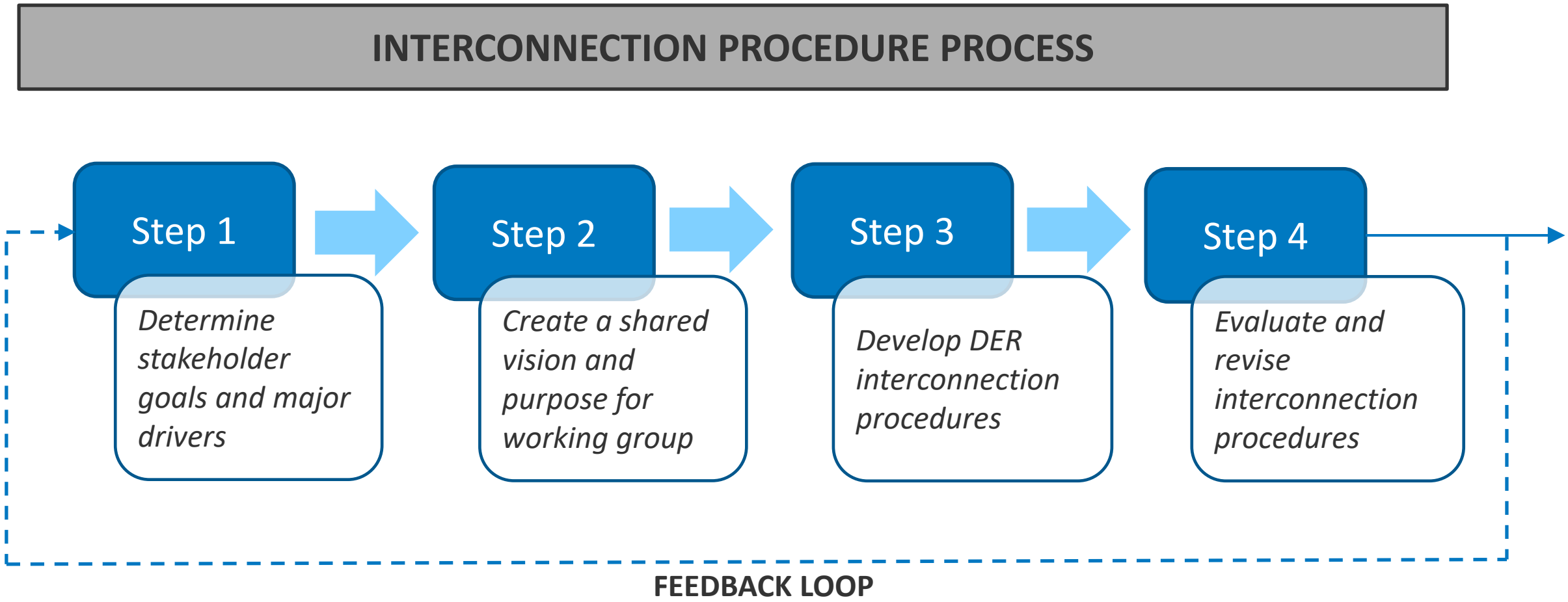
Updating Interconnection Procedures and Incorporating IEEE-1547

Michael Ingram, PE, FIEEE
Chief Engineer, Power Systems Engineering Center

2020 Winter Policy Summit of the
National Association of Regulatory Utility Commissioners

February 9, 2020

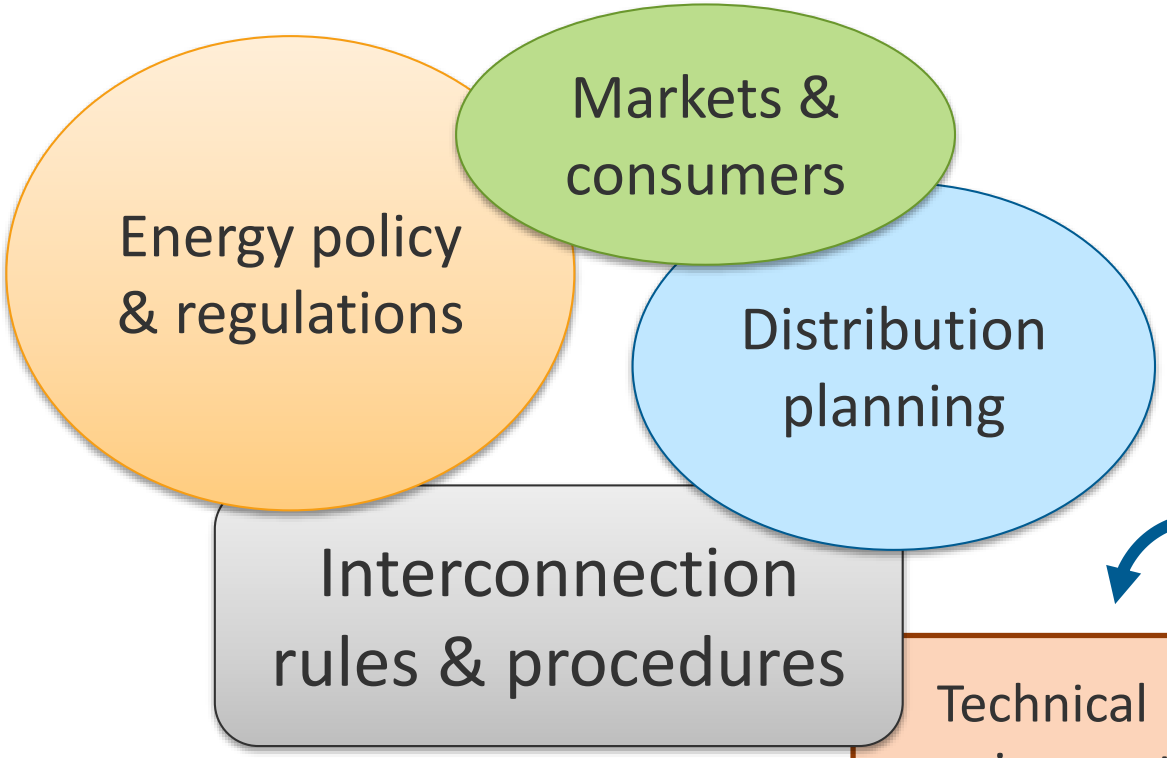
Updating Interconnection Procedures and Incorporating IEEE Std 1547-2018



Images from NREL

Context for IEEE Std 1547-2018 (Steps 1 & 2)

Images from NREL



Needs action for updates, additional education, and training

IEEE Std. 1547 and related standards

IEEE Std 1547
Requirements
Interconnection system and test
April 2018

IEEE Std 1547.1
Test procedures
Conformance
Expected Q1/Q2 2020

UL 1741
Certification
Equipment safety, performance
Expected Q2/Q3 2020

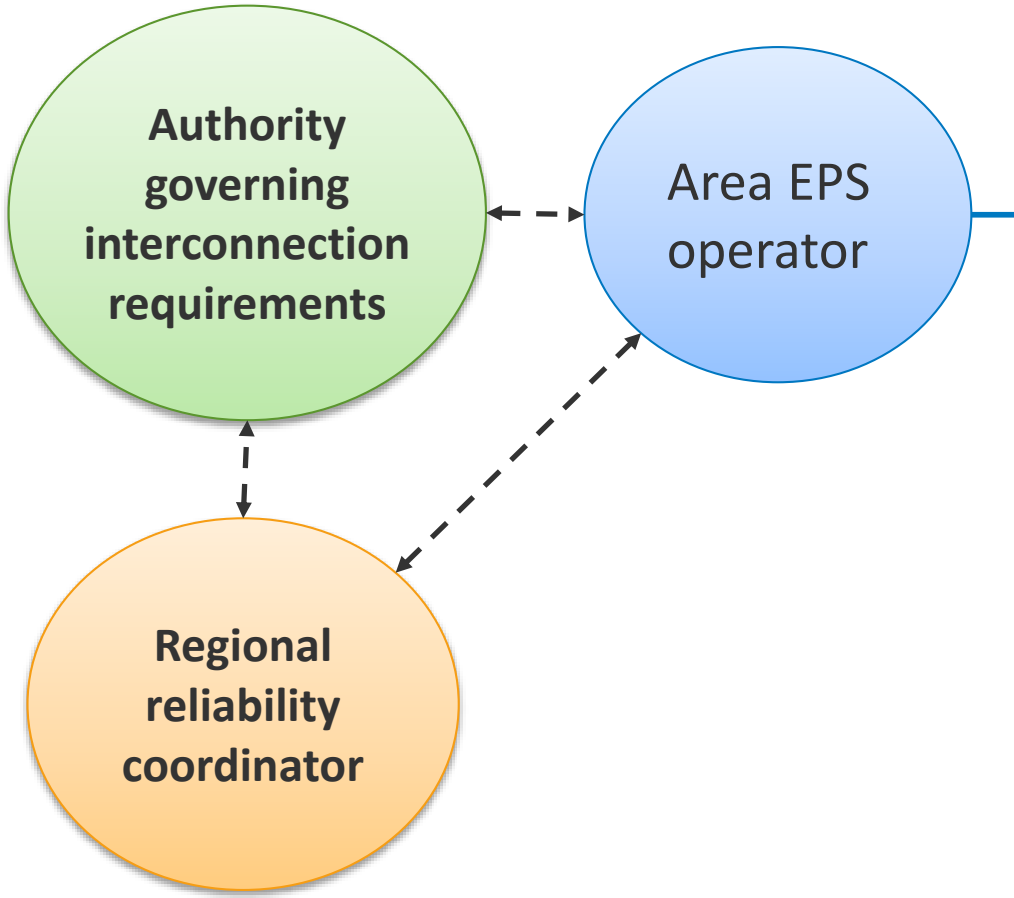
New compliant inverters expected Q4 2020/21

NFPA70 (National Electric Code)
Equipment Installation Safety Code
Current 2017, next 2020

Other decisions regarding broader distributed energy resources (DER) grid integration and/or grid modernization topics are outside IEEE Std 1547; however, the standard might provide relevant requirements that support those discussions.

Developing Technical Requirements (Step 3)

Input and decisions required by:



Important DER capabilities
(IEEE Std. 1547 requirements)

- Safety, power quality, & protection
- Testing & certification
- Voltage regulation
- Interoperability
- Support for bulk system reliability

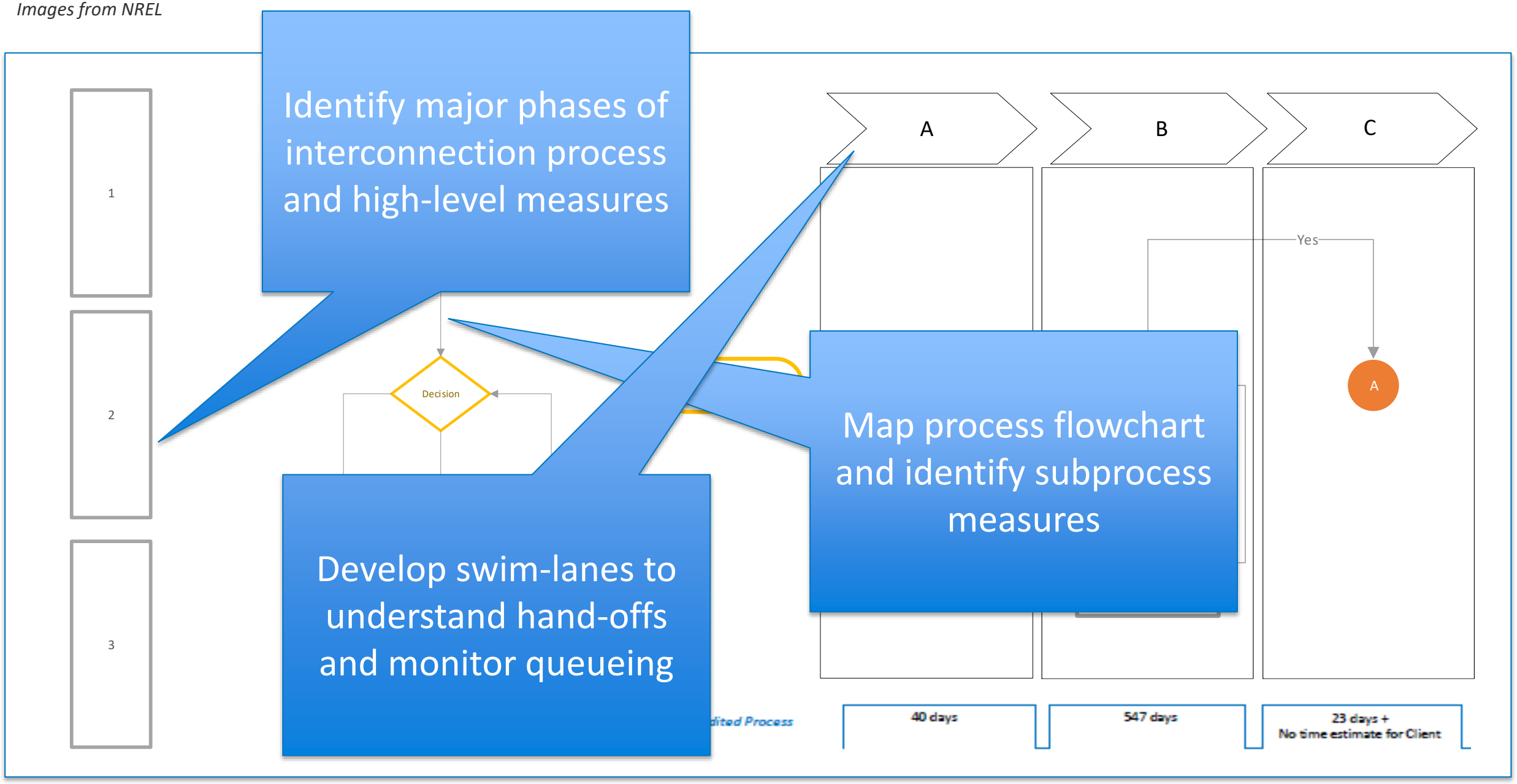
Application to grid modernization
(beyond 1547 scope)

- Voltage regulation → Grid services
- Interoperability → Grid services, Cybersecurity
- Support for bulk system reliability → Bulk system standards, Resilience, Black start

Images from NREL

Managing and Maintaining the Rule (Step 4)

Images from NREL



Give us your feedback

Stakeholder priorities for IEEE Std 1547-2018 training and education

English

Español

https://www.surveymonkey.com/r/IEEE-1547-2018

https://es.surveymonkey.com/r/DPG6FHW

National Renewable Energy Laboratory – Golden, Colorado
Photo by Dennis Schroder

Thank You

Michael Ingram| Michael.Ingram@NREL.gov

www.nrel.gov

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

NREL
Transforming ENERGY

The Future of the U.S. Coal Fleet: Retrofit, Retire, or Change the Business Model?

NARUC Electric Committee

Monday, February 10, 2020

What's Next for PJM's Capacity Market: Market Implications and Effect on State Policies in the Wake of FERC's Expanded MOPR Decision.

NARUC Electric Committee

Monday, February 10, 2020

Retired with New Ownership: What Happens to Closed Nuclear Plants that are Purchased by New Companies?

NARUC Electric Committee

Monday, February 10, 2020

Juliann Edwards, VP, Business Development

Energy*Solutions*, Charlotte N.C.

Manage 90% of the nation's nuclear waste

Own 100% of the assets required for decommissioning

Executing 50% of the current decommissioning projects

Attained 100% of the commercial contract models

ENERGYSOLUTIONS

Commercial D&D Models

D&D MANAGEMENT MODEL 1

Owner-led with Integrated Decommissioning Contractor

The utility staff fills most of the positions while the contractor fills positions commensurate with the specialized skill sets needed for nuclear decommissioning. The utility gets the full benefit of the contractor’s know-how and has access to its intellectual property.

- Utility interfaces with regulators and stakeholders
- Job creation for existing employees
- Cost savings are retained by utility and ratepayers

D&D MANAGEMENT MODEL 2

Utility-owned with Decommissioning General Contractor (DGC)

The utility continues to own the license and maintains responsibility for the overall project and management of spent fuel. Major D&D work is awarded to an experienced contractor responsible for execution, cost, and schedule.

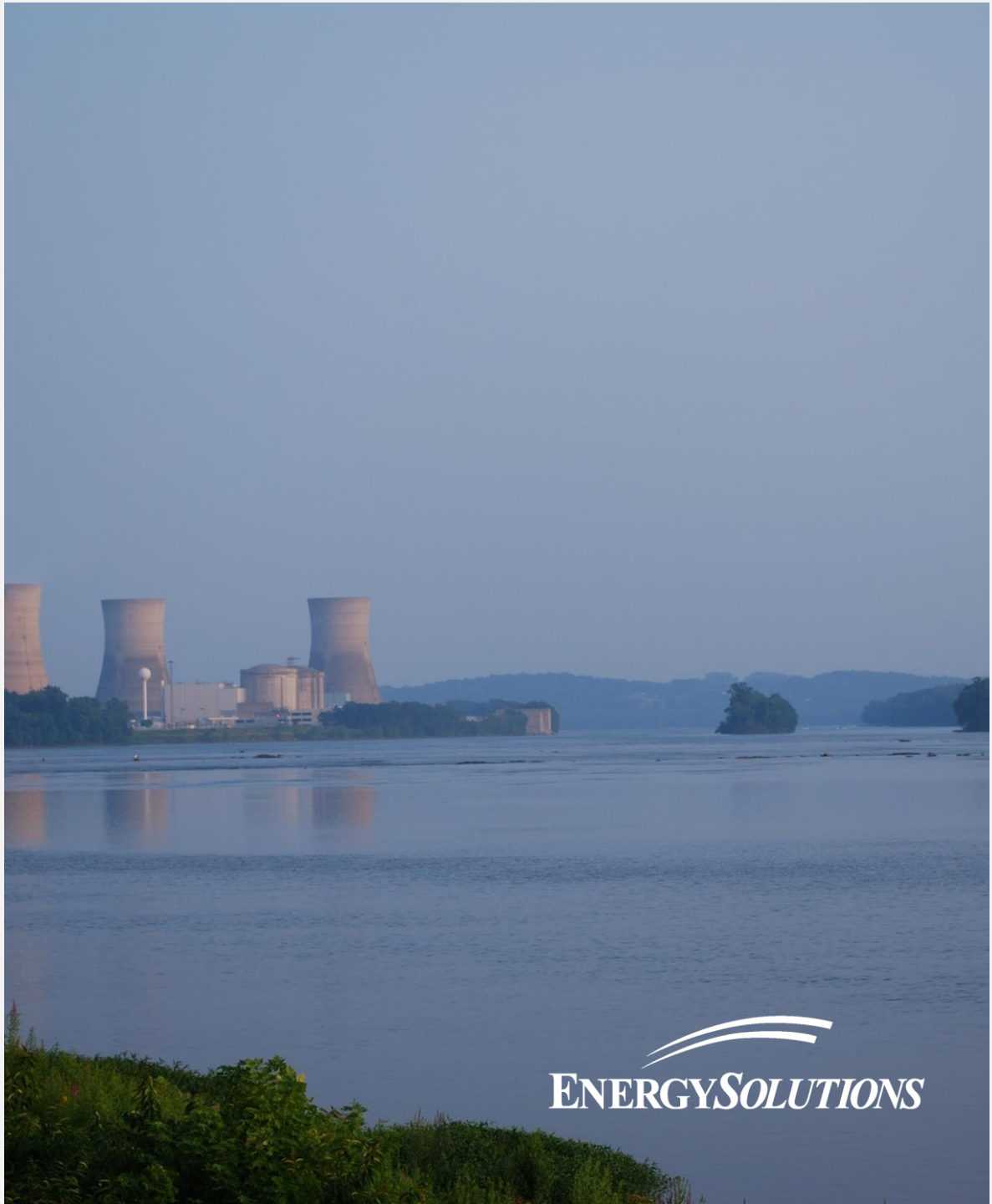
- Performance risk to DGC through target/fixed-price terms
- Job creation for some existing utility employees
- Cost savings retained by utility and ratepayers

D&D MANAGEMENT MODEL 3

Asset Transfer

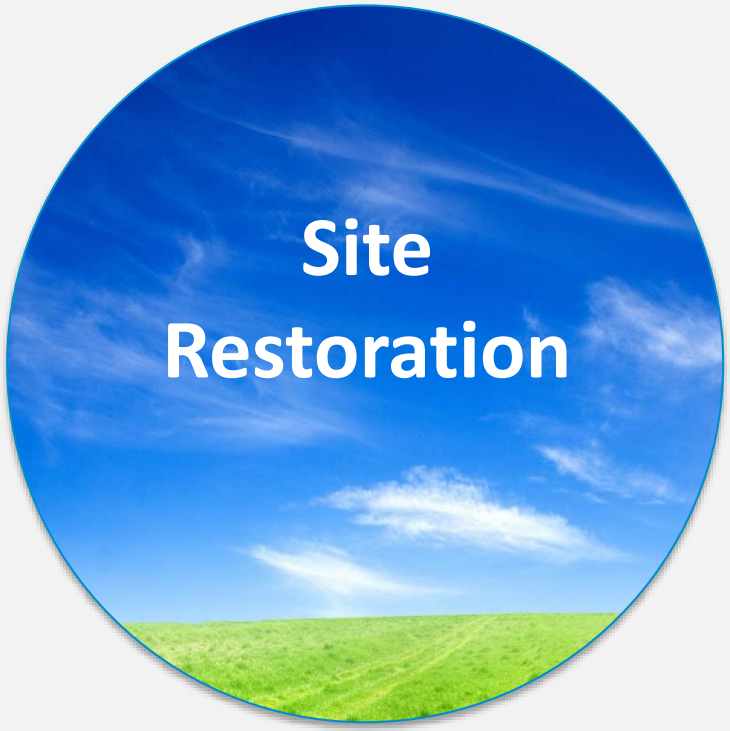
This model the utility owner transfers all licensee liabilities to the contractor. There have been varying examples of this model which may or may not include the transfer of property and spent fuel in exchange for NDT funds.

- SPE assumes full responsibility, performance, and cost risks for all decommissioning and licensing activities
- SPE takes ownership and accountability of nuclear decommissioning fund (NDT)
- SPE takes ownership and responsibility for spent nuclear fuel



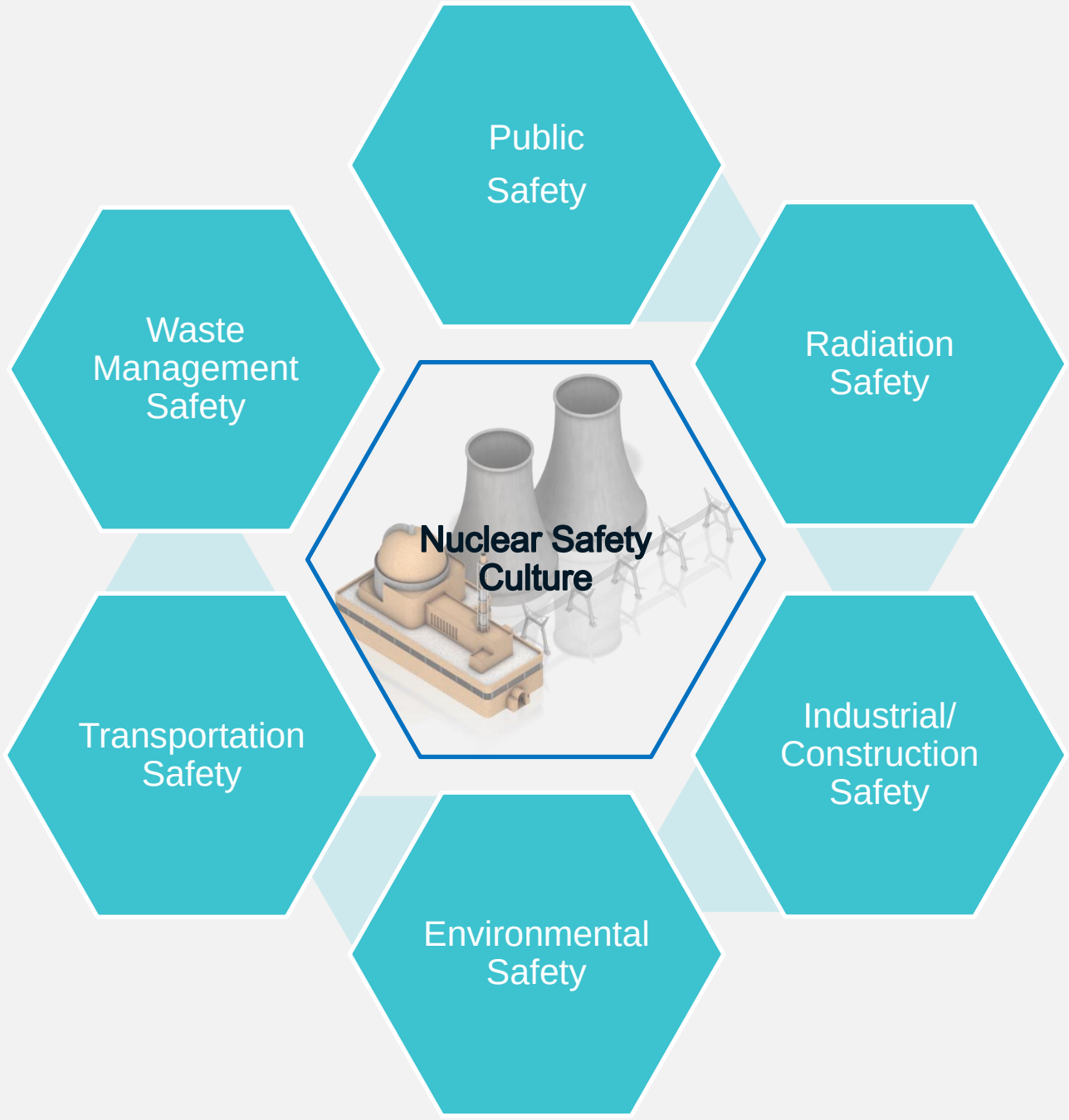
External Stakeholder Focus

Major D&D Milestones



ENERGYSOLUTIONS

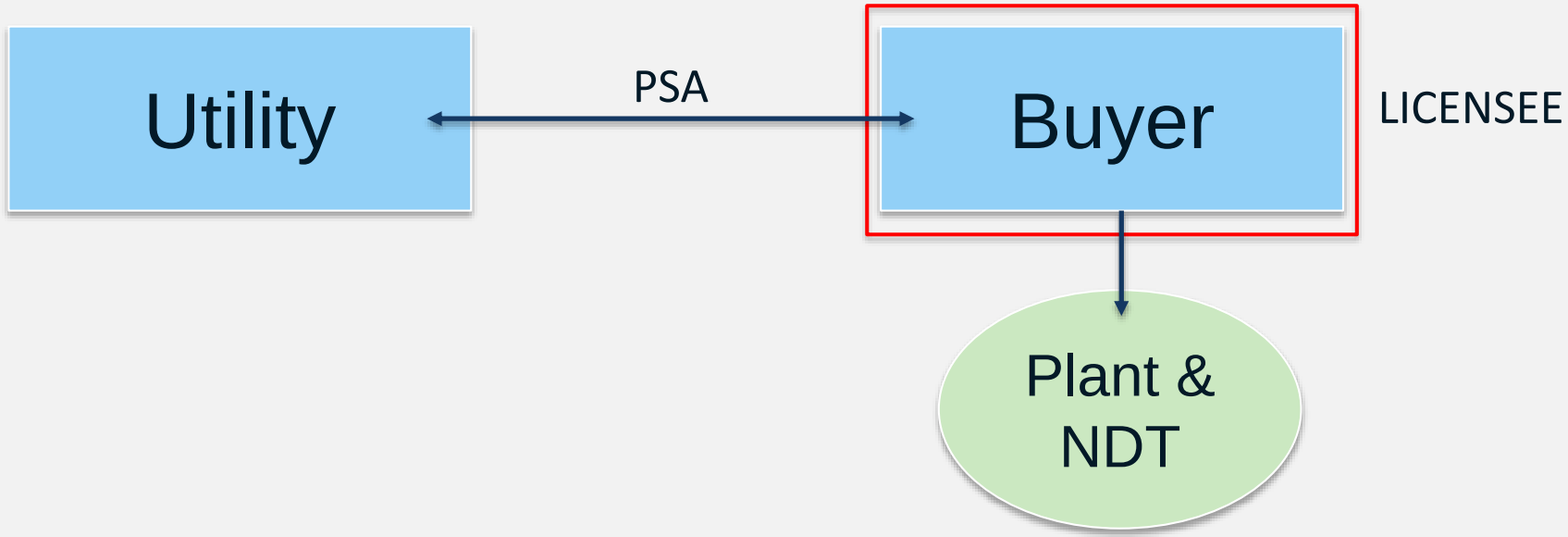
Safety


Public Safety
Radiation Safety
Industrial/ Construction Safety
Environmental Safety
Transportation Safety
Waste Management Safety
Nuclear Safety Culture

Financial Assurance

Asset Transfer Example

- VY, Oyster, Pilgrim, IPEC, Palisades, TMI-2
- License transferred
- NDT funds transferred along plant assets/ equity interests
- Funding risks addressed in sale diligence and negotiations
- New owner ultimately responsible to regulators



Community Engagement Panel (CEP)

Purpose	Keep the public and community stakeholders informed on project progress, major progress events and allow the community to be involved
When	Quarterly for the duration of the project from license transfer through project completion
Who	General public, elected officials, regulators, environmental agencies and the press
Topics	Project updates including schedule, major milestones safety updates Q&A

Thank You

Retired with New Ownership

NARUC Winter Policy Summit

February 10, 2020

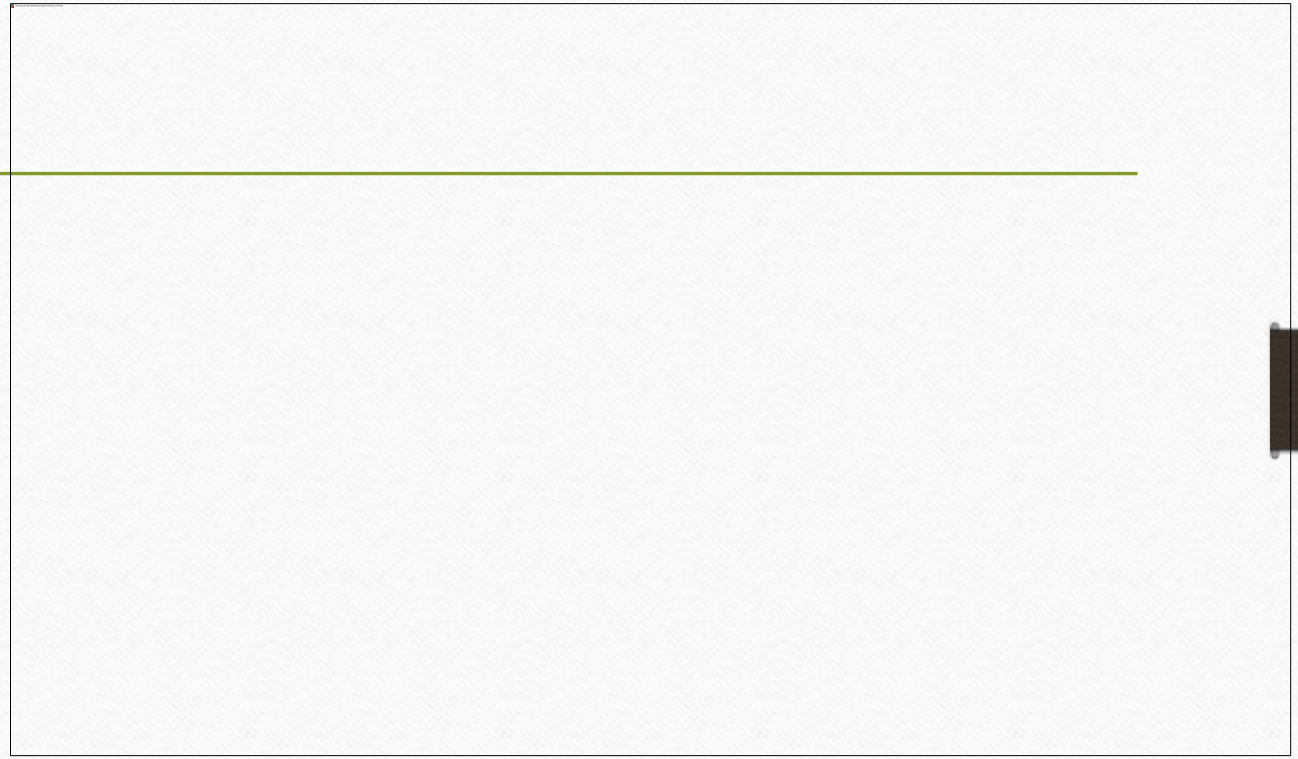
Sarah Hofmann, Commissioner

VERMONT

PUBLIC UTILITY COMMISSION

The Annoying Disclaimer Slide

ANYTHING I SAY WHETHER BRILLIANT OR INCREDIBLY STUPID IS MINE ALONE AND NOT THAT OF MY COMMISSION OR THE STATE OF VERMONT.



Our New Reality

Permanently & Announced Shutdown Nuclear Plant Sites

1. **Big Rock**
Charlevoix, MI

2. **Beaver Valley**
Shippingport, PA
Announced Shutdown, 2021

3. **Connecticut Yankee**
Haddam Neck, CT

4. **Crystal River**
Crystal River, FL

5. **Diablo Canyon**
Avila Beach, CA
Announced Shutdown, 2025

6. **Duane Arnold**
Palo, IA
Announced Shutdown, 2020

7. **Fort Calhoun**
Blair, NE

8. **Humboldt Bay**
Eureka, CA

9. **Indian Point**
Buchanan, NY
Announced Shutdown, 2021

10. **Kewaunee**
Kewaunee, WI

11. **La Crosse**
La Crosse, WI

12. **Maine Yankee**
Wiscasset, ME

13. **Oyster Creek**
Leeds Point, NJ

14. **Palisades**
Covert, MI
Announced Shutdown, 2022

15. **Pilgrim**
Plymouth, MA

16. **Rancho Seco**
Herald, CA

17. **San Onofre**
Pendleton, CA

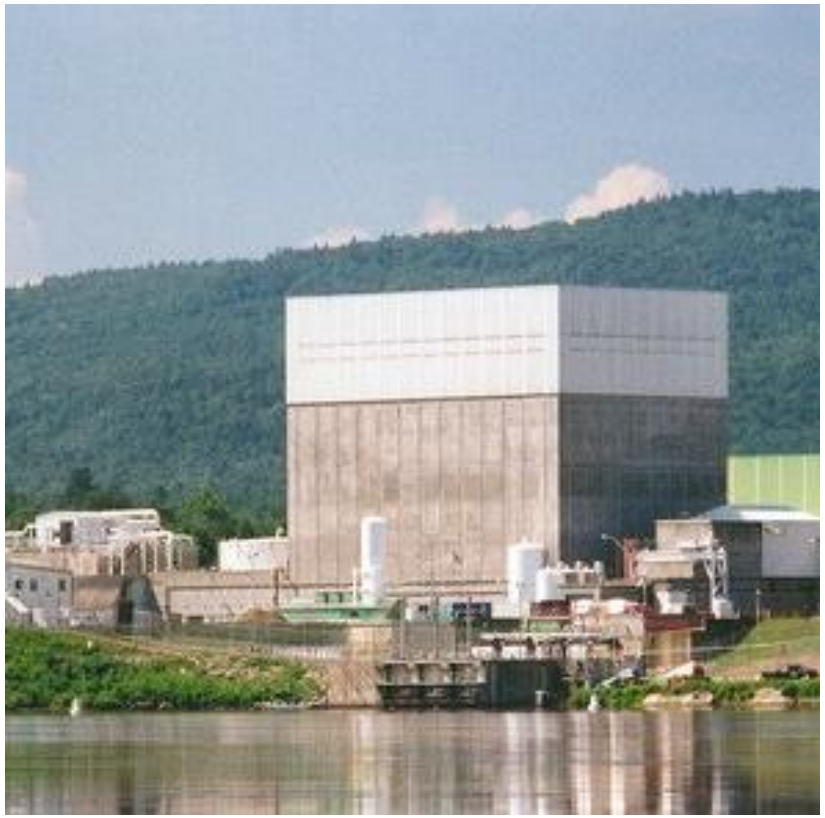
18. **Three Mile Island**
Middletown, PA

19. **Trojan**
Ranier, OR

20. **Vermont Yankee**
Vernon, VT

21. **Yankee Rowe**
Rowe, MA

22. **Zion**
Zion, IL



VERMONT YANKEE

- BWR began operations in 1972
- An Entergy sub. bought all the assets in 2002, including a decom fund of ≈ $310 M
- Permanent shut down on January 12, 2015
- The Entergy PSDAR estimated license termination by 2075

ENTER NORTHSTAR

- In February of 2017 Entergy and NorthStar Group Service, Inc. asked to transfer the VY station to North Star
- As of March 2018, the nuclear decommissioning trust had a balance of $559.7 M and a site restoration trust of $30.9 M.
- NorthStar had decommissioning experience related to four research reactors and also with DOE sites but not with a commercial reactor
- NorthStar committed to advancing the decommissioning of VY by more than 30 years

What's a State to do??????

KEY FACTORS IN APPROVAL

- Financial protections and risk-management provisions agreed to by the parties including enhanced financial assurances for decommissioning and site restoration
- Extensive oversight by Vermont agencies throughout the cleanup process
- U.S. NRC determination that NorthStar is financially and technically qualified to complete the decommissioning according to the proposed schedule
- Broad support of the public and the parties (including State, regional, and local governmental authorities) for the transfer

HIGHLIGHTS OF THE DEAL

- NorthStar within 12 years will remove most above-ground structures, and underground structures (to a depth of 4'), and the site will be regraded and seeded.
- Entergy contribution to the site restoration trust fund to bring it to $60 M
- NorthStar performance bond of approximately $400 M
- NorthStar parent support agreement of $140 M
- NorthStar provides $30 M of pollution legal liability insurance
- NorthStar contributes $10 M of proceeds from Round 3 of DOE claims

The Final Order and MOU

https://puc.vermont.gov/sites/psbnew/files/doc_library/8880%20Final%20Order.pdf

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

REACTOR DECOMMISSIONING FINANCIAL ASSURANCE WORKING GROUP

February 10, 2020

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

WG Charter

In September 2019, the Reactor Decommissioning Financial Assurance Working Group was formed and directed to:

1. Review the current decommissioning financial assurance processes
2. Identify potential regulatory gaps or policy issues
3. Identify potential program enhancements
4. Identify planning or resource considerations
5. Make recommendations

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United States Nuclear Regulatory Commission
Protecting People and the Environment

Regulations Governing Decommissioning Financial Assurance

1988, "General Requirements for Decommissioning Nuclear Facilities"

- 10 CFR 50.75

1996 "Decommissioning of Nuclear Power Reactors"

- 10 CFR 50.82

1998 "Financial Assurance Requirements for Decommissioning Nuclear Power Reactors"

- 10 CFR 50.75 (f)(1) and (2)

2002 "Decommissioning Trust Provisions"

- Corrected in 2003
- Additional financial assurance requirements for licensees that are not traditional regulated electric utilities

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Protecting People and the Environment

NRC Perspective

The risk of a licensee not having adequate decommissioning resources is low because:

1. Extensive regulations
2. Transfer requires NRC approval of financial resources
3. NRC inspection program
4. Atomic Energy Act authority

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Protecting People and the Environment

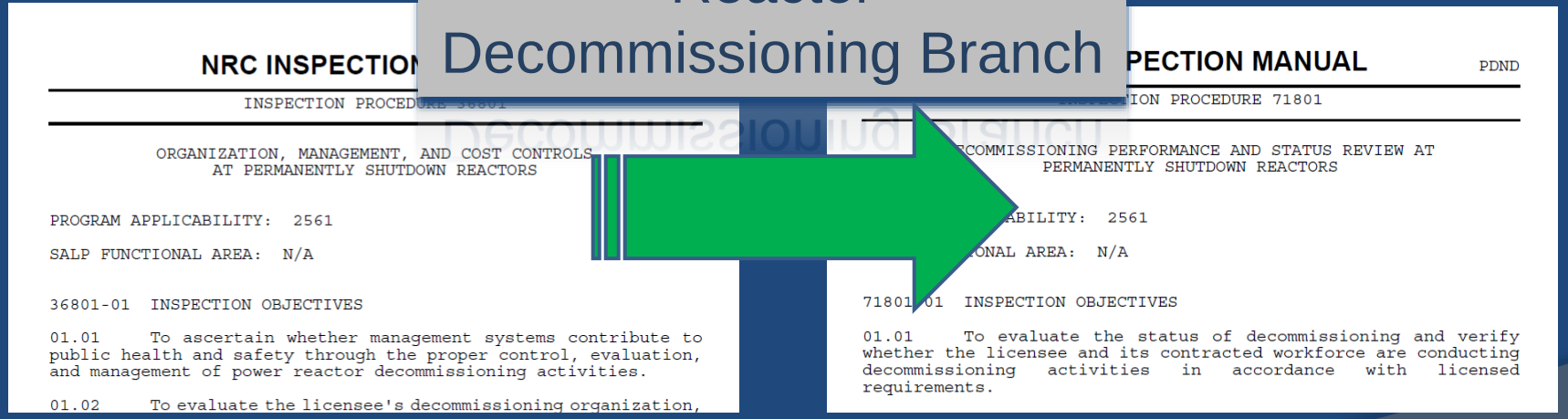
WG Progress Summary

- No regulatory gaps or policy issues have been identified
- Recommendations developed to improve FA licensing and oversight processes
  - Four guidance initiatives
  - Training for inspectors, program office and financial analysts

Recommended Guidance Initiatives

1. Revise Inspection Procedures
   - Integrate decommissioning activity inspections with the program office and financial analysts activities

Reactor Decommissioning Branch



NRC INSPECTION MANUAL

INSPECTION PROCEDURE 36801

ORGANIZATION, MANAGEMENT, AND COST CONTROLS AT PERMANENTLY SHUTDOWN REACTORS

PROGRAM APPLICABILITY: 2561

SALP FUNCTIONAL AREA: N/A

36801-01 INSPECTION OBJECTIVES

01.01 To ascertain whether management systems contribute to public health and safety through the proper control, evaluation, and management of power reactor decommissioning activities.

01.02 To evaluate the licensee's decommissioning organization,

PECTION MANUAL PDND

ION PROCEDURE 71801

COMMISSIONING PERFORMANCE AND STATUS REVIEW AT PERMANENTLY SHUTDOWN REACTORS

ABILITY: 2561

ONAL AREA: N/A

71801-01 INSPECTION OBJECTIVES

01.01 To evaluate the status of decommissioning and verify whether the licensee and its contracted workforce are conducting decommissioning activities in accordance with licensed requirements.

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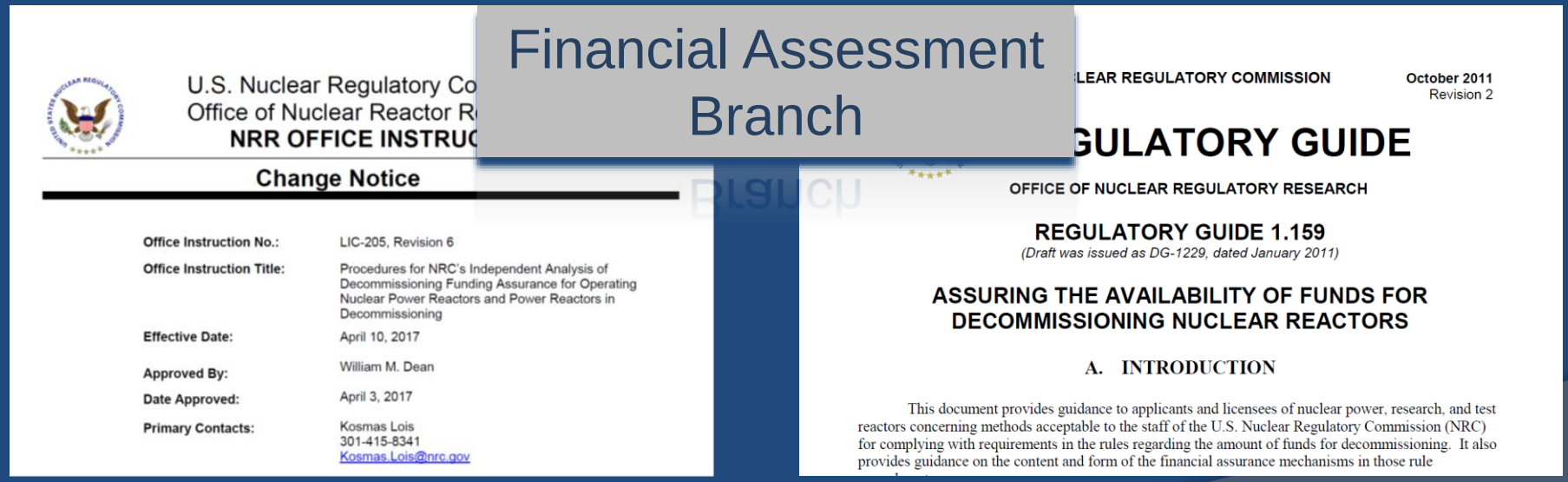
Recommended Guidance Initiatives

2. Revise Reporting Guidance to allow more detail in annual reports for improved oversight of DTF expenditures



U.S. Nuclear Regulatory Co
Office of Nuclear Reactor R
NRR OFFICE INSTRUC

Change Notice

Office Instruction No.:	LIC-205, Revision 6
Office Instruction Title:	Procedures for NRC's Independent Analysis of Decommissioning Funding Assurance for Operating Nuclear Power Reactors and Power Reactors in Decommissioning
Effective Date:	April 10, 2017
Approved By:	William M. Dean
Date Approved:	April 3, 2017
Primary Contacts:	Kosmas Lois 301-415-8341 Kosmas.Lois@nrc.gov

Financial Assessment Branch

LEAR REGULATORY COMMISSION

October 2011
Revision 2

GULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.159
(Draft was issued as DG-1229, dated January 2011)

ASSURING THE AVAILABILITY OF FUNDS FOR DECOMMISSIONING NUCLEAR REACTORS

A. INTRODUCTION

This document provides guidance to applicants and licensees of nuclear power, research, and test reactors concerning methods acceptable to the staff of the U.S. Nuclear Regulatory Commission (NRC) for complying with requirements in the rules regarding the amount of funds for decommissioning. It also provides guidance on the content and form of the financial assurance mechanisms in those rule

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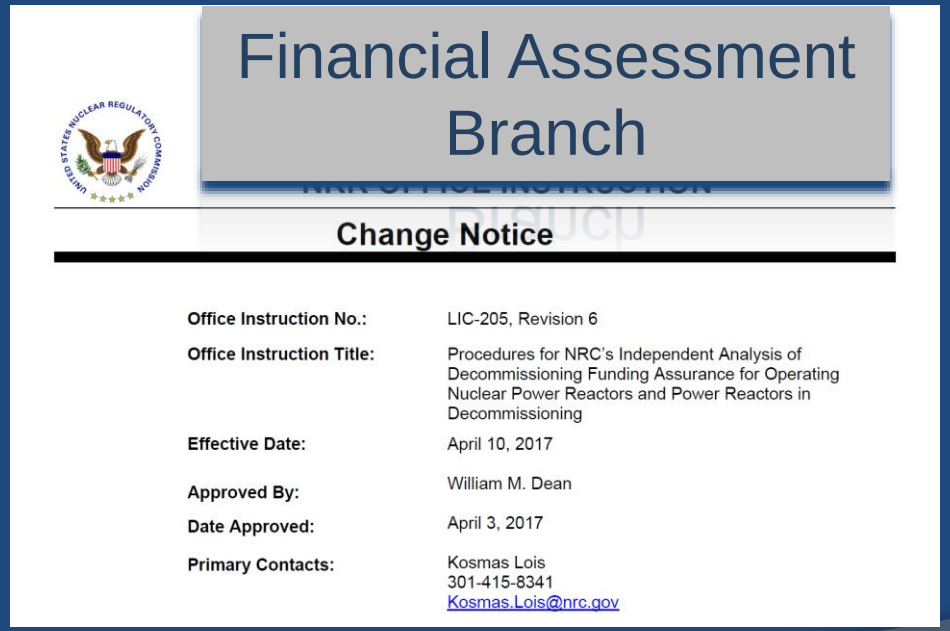
Recommended Guidance Initiatives

3. Revise Reporting Guidance to allow more detail in the 30-day pre-withdrawal notices for improved oversight of DTF expenditures



Financial Assessment Branch

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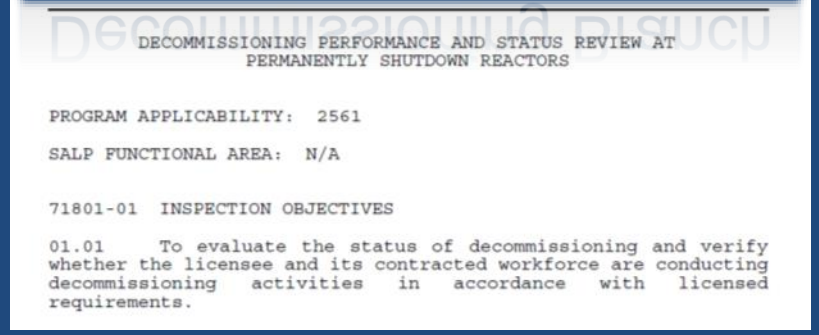
Recommended Guidance Initiatives

4. Develop guidance for a spot check program for power reactors in decommissioning

Reactor Decommissioning Branch



DECOMMISSIONING PERFORMANCE AND STATUS REVIEW AT PERMANENTLY SHUTDOWN REACTORS

PROGRAM APPLICABILITY: 2561

SALP FUNCTIONAL AREA: N/A

71801-01 INSPECTION OBJECTIVES

01.01 To evaluate the status of decommissioning and verify whether the licensee and its contracted workforce are conducting decommissioning activities in accordance with licensed requirements.

Financial Assessment Branch

NRR OFFICE INSTRUCTION

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Training

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Applicable Guidance

- NUREG-1307, Rev 17
  - ML19037A405
- Regulatory Guide 1.159
  - ML112160012
- Regulatory Guide 1.202
  - ML050230008
- NRR Office Instruction LIC-205
  - ML17075A095
- Inspection Procedure 36801/71801
  - https://www.nrc.gov/reading-rm/doc-collections/insp-manual/inspection-procedure/

Thank you

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United States Nuclear Regulatory Commission
Protecting People and the Environment

Backup slides

Decommissioning Business Models

- Historically, decommissioning has been managed by former operator
- Recently, plants have been transferred for decommissioning
- Transfers require a financial qualification evaluation

Working Group

Organizations

- Office of Nuclear Material Safety and Safeguards
  - Division of Decommissioning, Uranium Recovery and Waste Programs
  - Division of Rulemaking, Environmental and Financial Support
- Office of Nuclear Reactor Regulation
  - Division of Operating Reactor Licensing
- Region I - Division of Nuclear Materials Safety
- Region III - Division of Nuclear Materials Safety
- Region IV – Division of Nuclear Materials Safety
- Office of General Counsel

Chairman: Ted Smith, Reactor Decommissioning Branch

Summary of Decommissioning Financial Assurance Requirements (1 of 3)

Assurance of sufficient funding for decommissioning is provided by:

1. Calculated decommissioning cost estimate cost updated annually
2. Decommissioning cost must be covered
3. Trustee manages the decommissioning trust fund (DTF) with NRC oversight

Summary of Decommissioning Financial Assurance Requirements (2 of 3)

Assurance of sufficient funding for decommissioning is provided by:

4. Withdrawal notification requirements while operating
5. Withdrawals limited to radiological decommissioning
6. Periodic reports with obligation to make up shortfalls

Summary of Decommissioning Financial Assurance Requirements (3 of 3)

Assurance of sufficient funding for decommissioning is provided by:

7. Preliminary and site-specific decommissioning cost estimates
8. Obligation to make up shortfalls immediately when in decommissioning
9. 60 years to complete decommissioning
10. Ability to revoke exemptions for other use of DTFs

U.S.NRC
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Protecting People and the Environment

Electricity Committee Business Meeting

Featuring
Hon. Bernard McNamee (FERC)

Monday, February 10, 2020

Electric Reliability and Capacity: What's the Role of Resource Adequacy for Keeping the Lights On?

NARUC Electric Committee

Tuesday February 11, 2020

The Next Perfect Storm

NARUC Electric Committee

Tuesday February 11, 2020

Commissioner Mathews

Kentucky Public Service Commission

Dr. Mathews was the executive director of the PSC. She had previously served the PSC as a policy advisor and as staff economist. Commissioner Mathews also has served Kentucky as an economist in the state Office of Energy Policy, as executive director of the Governor's Office of Energy Policy, and in the Department for Energy Development and Independence as director of the Division of Energy Generation, Transmission and Distribution.

In addition to nearly two decades of government service, Commissioner Mathews has worked in the private sector with an engineering consulting firm and served as the director of member services and advocacy at the Organization of MISO States. She has held several adjunct teaching positions in economics and public policy.

Commissioner O’Guinn

Arkansas Public Service Commission

Commissioner O’Guinn received a Bachelor of Science in Environmental Engineering from the University of Oklahoma. Prior to her appointment to the Arkansas Public Service Commission, she served as the Director of Communications for the Arkansas Department of Environmental Quality (ADEQ). Commissioner O’Guinn also served as an Engineer in the Office of Air Quality for ADEQ for sixteen years. Commissioner O’Guinn serves on the Executive Committee and the Board of Directors of the National Association of Regulator Utility Commissioner. She also serves as a Board Member and past President of the Southwest Power Pool (SPP) Regional State Committee.

Linda Apsey

President and CEO ITC Holdings

Linda Apsey is President and CEO for ITC Holdings Corp. In this role, she is responsible for the strategic vision and overall business operation of ITC and its subsidiaries. Previously, Mrs. Apsey served as Executive Vice President and Chief Business Unit Officer, leading all aspects of the financial and operational performance of the company.

Mrs. Apsey also has served as Executive Vice President and Chief Business Officer, and President of ITC Michigan where she was responsible for the company's regulatory, marketing and communications, federal, state and local government affairs, and human resource functions.

Clair Moeller

President and COO MISO

As MISO president and COO, Clair Moeller leads all aspects of operations, including grid operations, forward markets and system planning. Moeller also has executive responsibility for the compliance and external affairs teams at MISO. Mr. Moeller is a respected industry expert with experience in the operation of power systems throughout the Midwest. He is skilled at identifying and implementing the best practices in transmission planning and systems operations.

Mr. Moeller earned a Bachelor of Science degree in electrical engineering from Iowa State University. He also completed the Oxford Advanced Management and Leadership course at Oxford Said Business School and the Executive Management program at the Carlson School of Business, University of Minnesota.

Under his guidance, transmission planners in the region have begun to explore transmission infrastructure value by using techniques borrowed from generation and strategic planners in an effort to give policymakers context for the decisions they will face in this dynamic energy environment.

Stu Bresler

Senior VP - Market Services PJM

Bresler is responsible for all aspects of PJM's market functions. His responsibilities cover all of the markets operated by PJM, including those for Capacity, Day-Ahead and Real-Time Energy, Ancillary Services, Financial Transmission Rights and Demand Response operations. Mr. Bresler is responsible for the continued evolution of PJM's markets, including the integration of renewable resources and the development of analytics around the performance of those markets. An employee of PJM since 1994, Mr. Bresler previously held other leadership and management positions within the Markets Division, as well as engineering positions in the Operations Division.

Mr. Bresler earned a Bachelor of Science in electrical engineering and a Master of Management in business administration from The Pennsylvania State University. He is a licensed professional engineer in the state of Pennsylvania.

Bryn Baker

Director – Renewable Energy Buyers Alliance (REBA)

Bryn Baker is REBA's Director of Policy Innovation, leading REBA's work to influence policy to expand opportunities and accelerate new policy approaches that allow all non-residential energy buyers to access cost-competitive renewable energy. Previously, Bryn led World Wildlife Fund's renewable energy work with large buyers that merged under the new REBA, including the Renewable Energy Buyers Principles initiative. Prior to joining WWF, Bryn worked for the Overseas Development Institute in London and the US Agency for International Development (USAID) on climate change and energy issues. Bryn holds a Masters in Environmental Policy from the London School of Economics and a BA in biology from the University of Colorado Boulder.

Chairman Zalewski

Illinois Commerce Commission

Carrie Zalewski was appointed Chairman of the Illinois Commerce Commission on April 15, 2019, by Governor JB Pritzker to a 5-year term.

Chairman Zalewski came to the Commission from the Illinois Pollution Control Board where she had served since 2009. At the Board, Zalewski adjudicated complex environmental cases under the Illinois Environmental Protection Act, shaped critical rulemaking and worked to properly balance the interests of Illinois businesses and residents while protecting Illinois' land, air, and water. Zalewski was appointed and reappointed to the Board under Democratic and Republican governors.

Before serving on the Illinois Pollution Board, Zalewski was Assistant Chief Counsel for the Illinois Department of Transportation (IDOT). While at IDOT, she deftly handled various environmental issues regarding NPDES permits and leaking underground storage tanks. She also provided counsel in other air, land and water issues, as well as in other transportation safety issues. Prior to that, Zalewski worked in private practice. She earned her Juris Doctor at the Chicago-Kent Law School and her Bachelor of Science in Engineering from the University of Illinois at Urbana-Champaign.

Commissioner White

Utah Public Service Commission

Jordan White was appointed to the Utah Public Service Commission in 2015. At the time of his appointment he was serving as the Commission's legal counsel. Prior to joining the Commission, Jordan practiced at the law firm Fabian VanCott in Salt Lake City where he represented clients on energy and natural resource matters. Jordan later worked as in-house counsel for energy companies including PacifiCorp and NextEra Energy, Inc., where his work focused on electric utility operations, competitive transmission development and regulatory matters.

Jordan previously served as President of the National Conference of Regulatory Attorneys, Chair of the Western Energy Imbalance Market Body of State Regulators, and as a Class 5 Representative on Peak Reliability's Member Advisory Committee. He currently serves as Vice Chair of the Western Interconnection Regional Advisory Body, Regulatory Liaison to RC West, and President of the Western Conference of Public Service Commissioners.

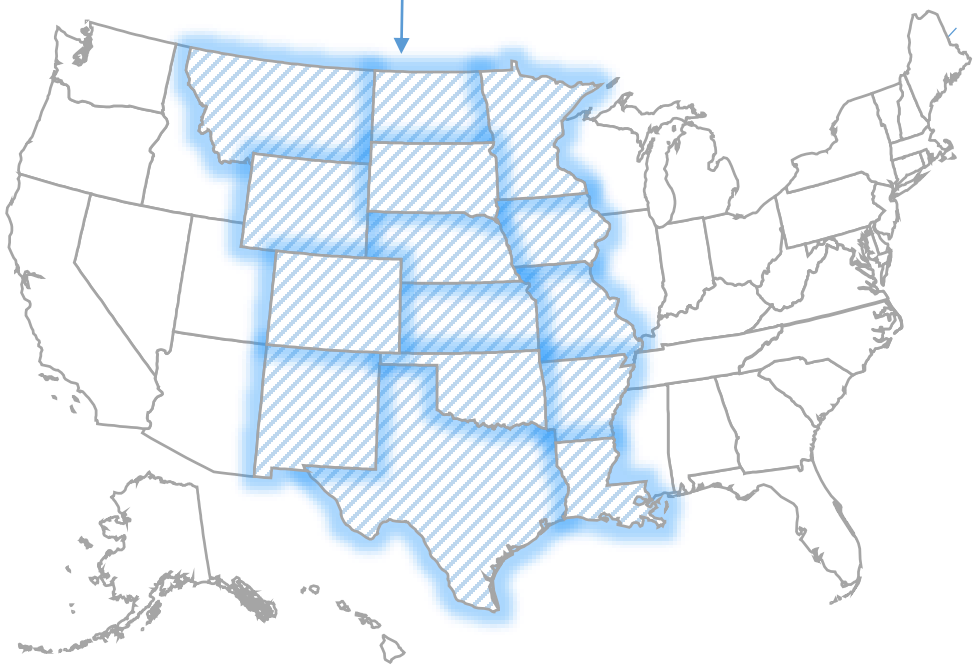
Before law school, Jordan practiced as a mental health therapist, working primarily with children and adolescents. He currently serves on the boards of YMCA of Northern Utah and Futures Through Choices, a non-profit organization that strives to enhance the lives of individuals with developmental disabilities. He received his undergraduate, masters of social work, and law degrees from the University of Utah.

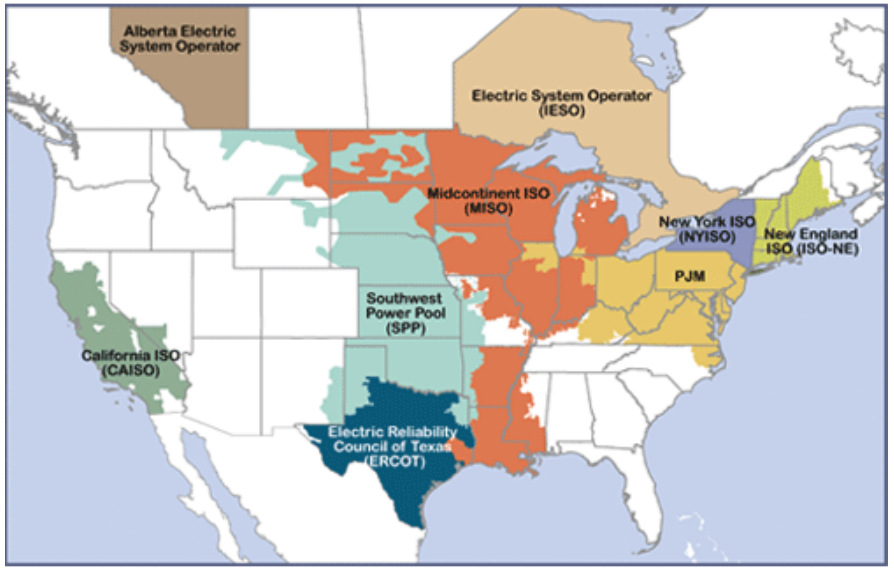
https://www.ekoenergy.org/buying-100-renewable-energy-is-becoming-the-new-normal/

https://www.ekoenergy.org/buying-100-renewable-energy-is-becoming-the-new-normal/

Transmission Expansion and Upgrades Needed

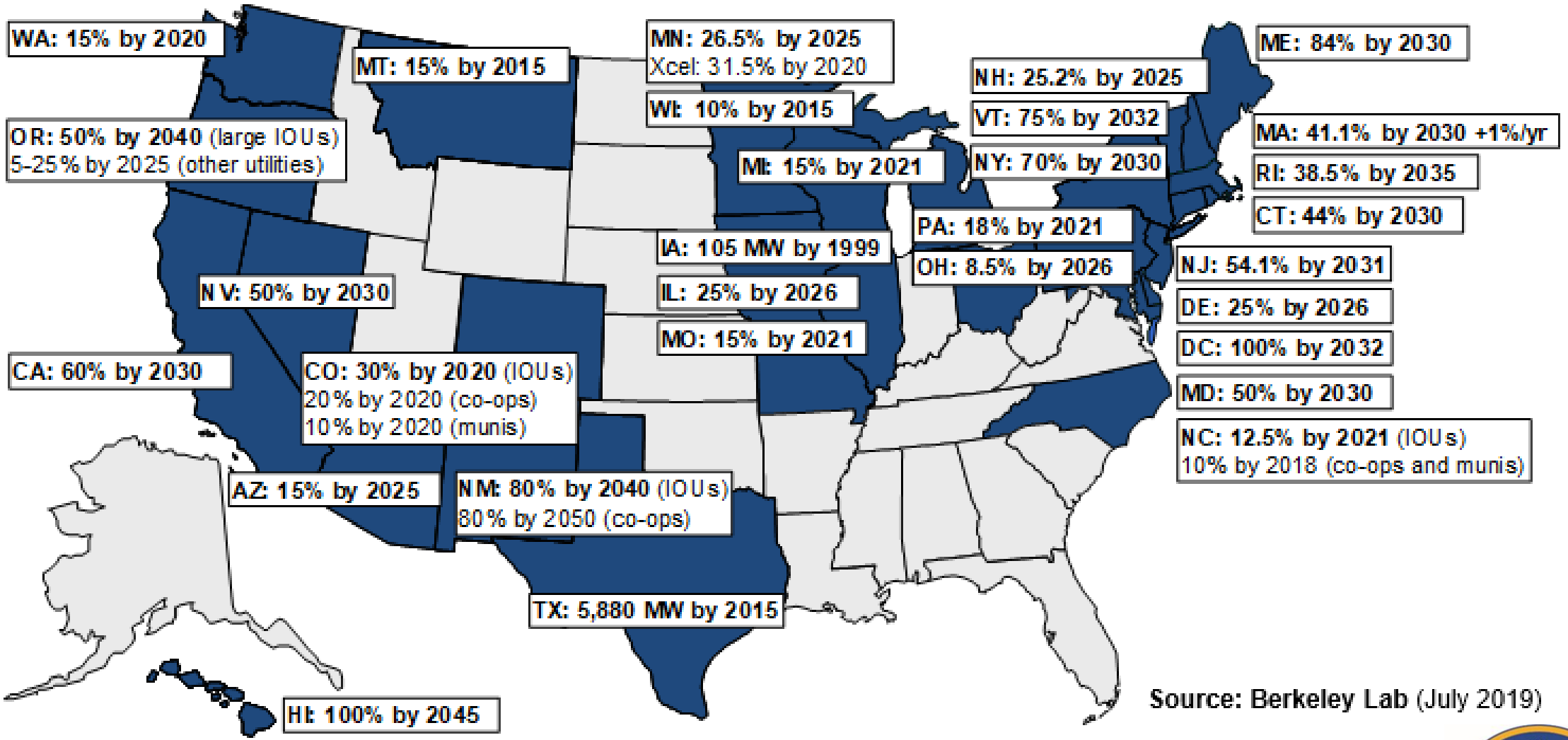
- 88% of total tech. potential for onshore wind
- 56% of total tech. potential for utility-scale solar PV
- 30% of total projected electricity sales, 2050





Sources: AWEA, U.S. Wind Industry Fourth Quarter 2016 Market Report
NREL, 2012 U.S. Renewable Energy Technical Potentials
EIA, Annual Energy Outlook 2017

Americans for a Clean Energy Grid



Source: Berkeley Lab (July 2019)

Audience Questions

Commissioner Mathews

Commissioner O'Guinn

Linda Apsey

Clair Moeller

Stu Bresler

Bryn Baker

Chairman Zalewski

Commissioner White

In Demand: Regulatory Considerations for Load Flexibility

Tuesday, February 11, 2020

Southern Company

In Demand:

Regulatory Considerations for Load Flexibility

Phil Markham
Smart Buildings R&D Manager
Southern Company
Feb 11th, 2020

Grid-interactive Efficient Buildings (GEB) Research

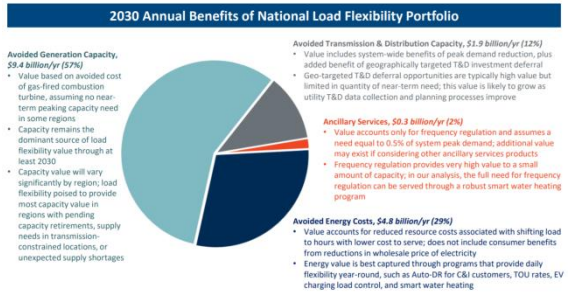
GEBs will be the fastest growing form of load flexibility in the next decade.

For many residential customers, controlling the HVAC & water heater means controlling 50% of the home's electric load.

An electric vehicle will be the home's largest or second largest load.

Flexible Load | Knowledge & Technology Gaps

What's the realistic resource opportunity?



What's the customer experience like?

Is flexible load a reliable resource, even in extreme weather?

Southern Company Smart Neighborhood Initiatives

Understanding tomorrow's home today

Two first-of-a-kind smart home communities at the intersection of energy efficiency, distributed energy resources & buildings-to-grid integration and the traditional utility model

Alabama Power SMART NEIGHBORHOOD®

- 62 single family homes
- Birmingham, AL
- Built to ~2035 building codes
- Flexible load control:
  - HVAC
  - Water heater

Oak Ridge National Laboratory | EPRI Electric Power Research Institute | Carrier® | Rheem®

Demonstrated the ability to dispatch the loads against a 15-min signal

Observed variations in customer comfort preferences

HVAC control in particular requires greater sophistication to be successful

Southern Company Smart Neighborhood Initiatives

Understanding tomorrow's home today

Two first-of-a-kind smart home communities at the intersection of energy efficiency, distributed energy resources & buildings-to-grid integration and the traditional utility model

Georgia Power Smart Neighborhood™

- 46 townhomes in Atlanta, GA
- Flexible load control:
  - Solar
  - Battery storage
  - HVAC
  - Water heater
  - EV charger

OAK RIDGE National Laboratory | EPRI ELECTRIC POWER RESEARCH INSTITUTE | DELTA | ecobee

Quantify the value of the added flexibility of the battery storage system and EV charger

Seek to incorporate greater sophistication in control algorithms e.g. personalized comfort models, occupancy detection, etc.

Flexible Load | Regulatory Considerations

Suggested Next Steps:

- Run pilots in partnership with regulators so that we all understand the opportunities and risks
- Demonstrate the performance and reliability of flexible load for operational applications before relying on them for longer-term planning decisions

Questions to Address:

- Can valuations for potential services provided by flexible load be developed accurately and fairly?
- Can we maintain (and hopefully improve) reliability?

THANKYOU!

Phil Markham
Smart Buildings R&D Manager
ppmarkha@southernco.com

A New Approach to Energy Affordability

Tuesday, February 11, 2020