Maintaining Reliability and Resilience in a Decarbonizing System

NCSL Annual Summit

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Explore EPRI's research across the Nuclear, Generation, and Power Delivery and Utilization sectors ranging from decarbonization to grid modernization to low carbon resources.

COLLABORATION

EPRI's collaborative platform is unrivaled. Our R&D:

- Leverages your research dollars
- Connects you to a global network of peers
- Accelerates deployment of technology
- Mitigates the risk and uncertainty of going it alone
- Positions you as a leader in addressing industrywide challenges

CREDIBILITY

EPRI's independent research is guided by our mission to benefit the public. We offer:

- Objective solutions
- A proven track record
- Scientifically based research you can trust

EXPERTISE

For more than 50 years, EPRI has been applying R&D to help solve real challenges. With EPRI, you can:

- Reduce expenses and increase productivity
- Be more resilient today and better prepared for tomorrow
- Access an industry repository of collective experiences, technical expertise, and training resources
- Extend your staff and make your teams more robust and more confident
- Benchmark, learn and share best practices
- Increase your awareness of challenges that others are facing and alternate solutions to challenges you might be facing
- Save time and money troubleshooting problems EPRI and its stakeholders have seen before

Who We Are

Founded in 1972, the Electric Power Research Institute (EPRI) is the world's preeminent independent, non-profit energy research and development organization, with offices around the world.

Our Experts

EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe.

Why Must Grid Operations and Planning Evolve?

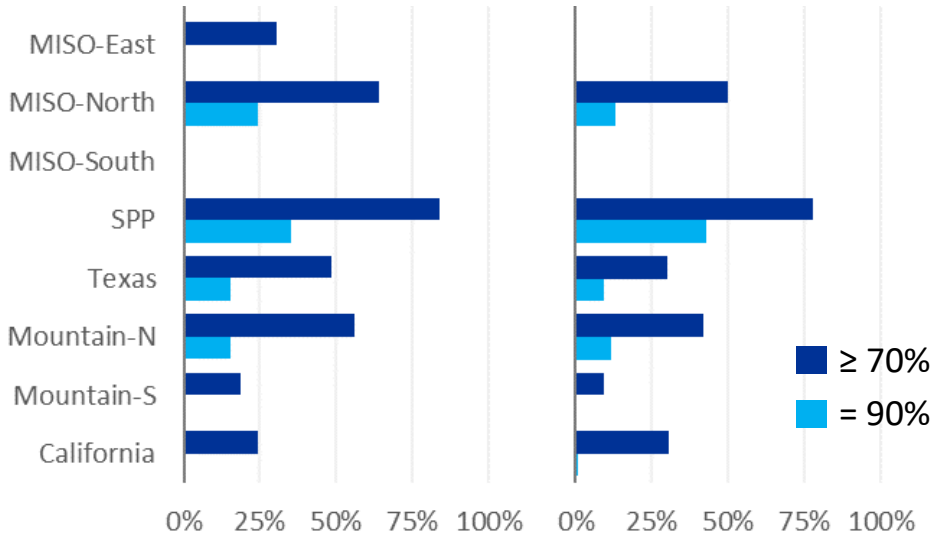
Changing Generation Mix

Active Distribution Systems

Consumer Control and Electrification

Increasing Reliability & Resiliency Through the Transition

Percentage of Annual Hours that Solar+Wind Supply >= 70% of Generation



Annual National Share Wind+Solar

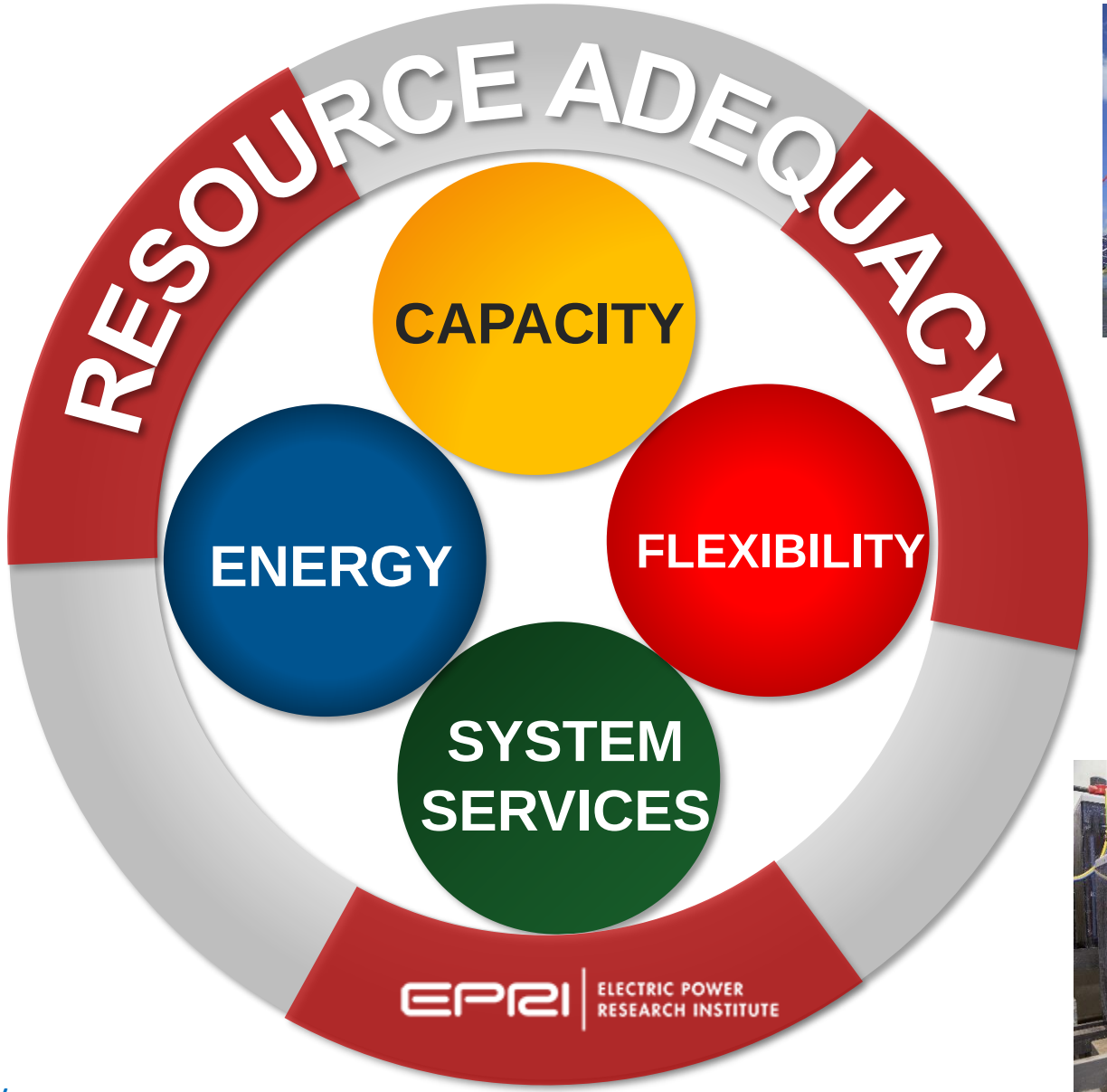
46%

32%

RESOURCE ADEQUACY	DELIVERY ADEQUACY
Additional resources to meet energy needs for resiliency to extreme future scenarios	Regional T&D capacity to integrate renewables and DER and serve increased electrification demand
BALANCING AND FLEXIBILITY	**GRID STABILITY**
Flexibility resources and operating reserves to manage variability and uncertainty	Resources and controls to maintain frequency and voltage for much faster dynamic system

A Decarbonized Grid must be more reliable and resilient as the grid becomes more dynamic, decentralized, and inverter-based in the context of changing climate and other hazards.

What does it mean to have adequate resources?



An adequate supply fleet is not just the installed MW in the ground. The capacity must have energy to sustain during critical time periods, flexibility to accommodate condition changes, and sufficient reliability services to provide when necessary

www.epri.com/resource-adequacy

Metrics and Criteria

Different metrics expose different levels of risk

LOLE is a frequency metric and typically evaluated on average

Metrics that include magnitude and duration expose additional risk

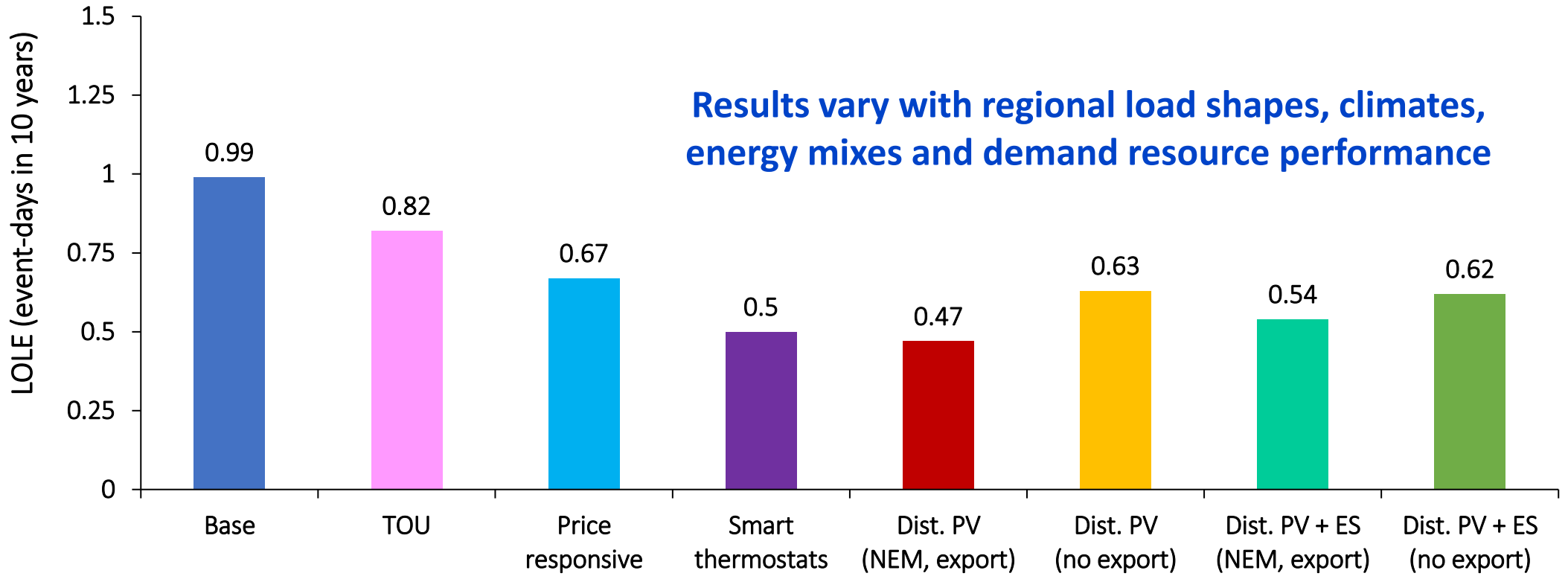
Potential for very different customer impacts for same LOLE level

NPCC Case Study: Risk conveyed by metrics			
Region	**Daily LOLE**	**Hourly LOLE**	**EUE-norm.**
A	0.10	0.15	0.37
B	0.10	0.34	0.99
C	0.10	0.39	3.37
D	0.10	0.25	1.00
E	0.10	0.48	2.54
F	0.10	0.28	0.34
Metric Scope	Frequency	+ Duration	+ Magnitude
Relative Risk	**Same**	**3X**	**10X**

EPRI Initiative provides Metric Viewer tool and guidance to select metrics that expose true risk

Demand Side Resources Can Support Adequacy

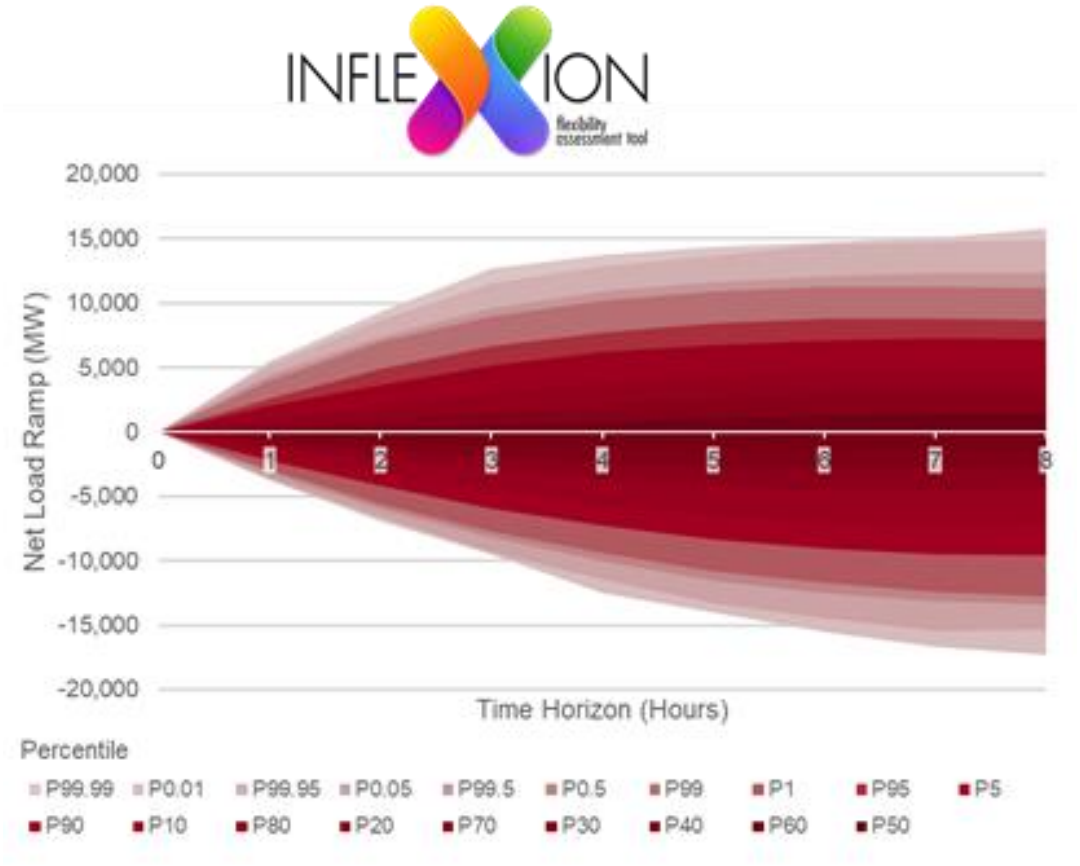
Potential reduction in LOLE from 900 MW (3% peak demand) of various distributed resource types (technology and tariff) for specific utility system

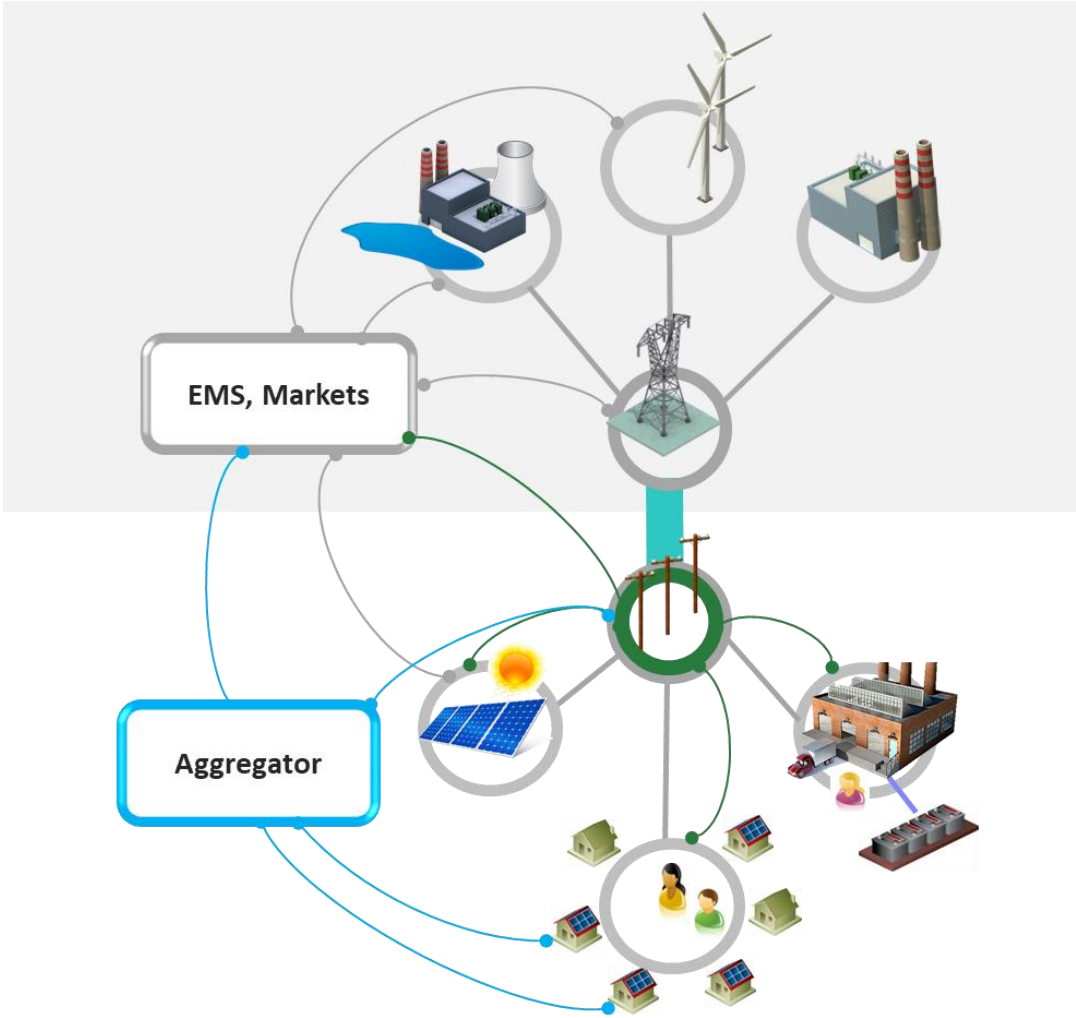


Results vary with regional load shapes, climates, energy mixes and demand resource performance

EPRI RAI provides methodology for modeling flexible demand contributions to RA

Flexibility – measuring needs and obtaining services

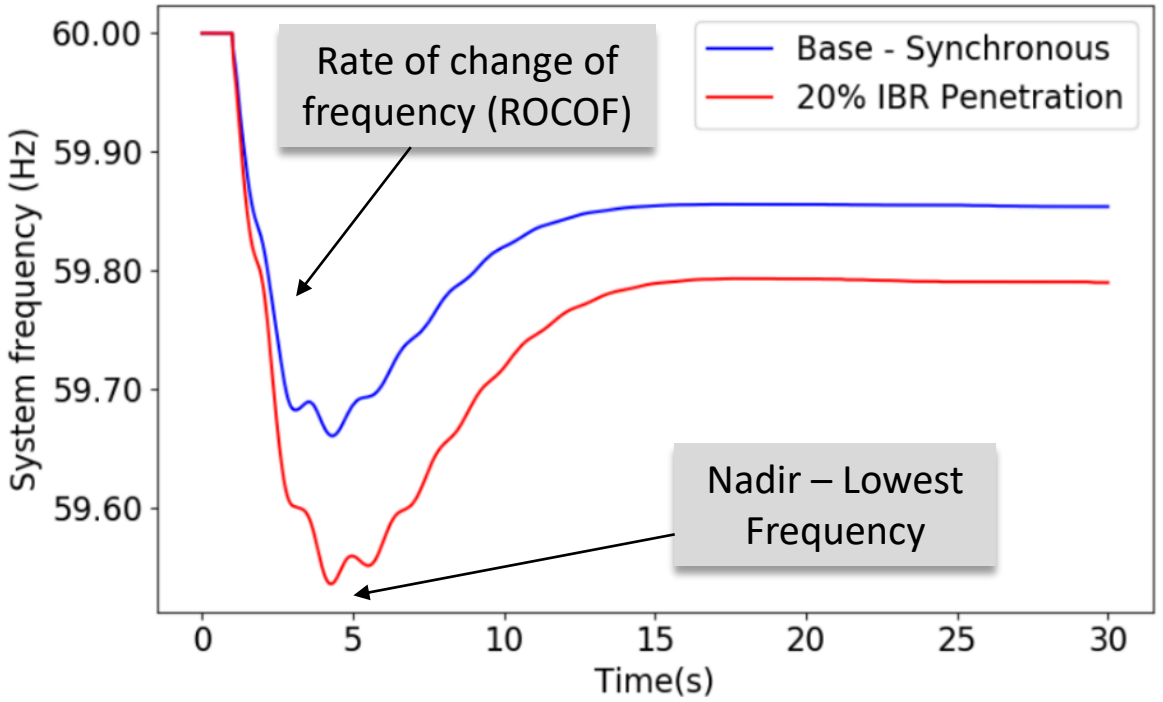




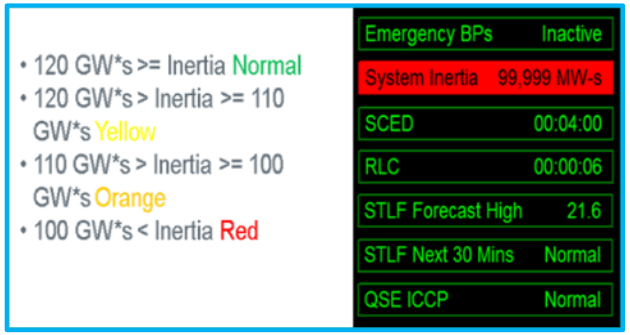
Need to be able to assess what is needed, and then get it from emerging resources

Grid Stability with Higher Renewables and Less Inertia

Inertia of a synchronous AC system opposes frequency changes after sudden generation loss



New Operating Practices/Capabilities



Online Inertia Monitoring and Inertia Floors

Redispatch to Reduce Largest Contingency

New Frequency Support Resources/Services

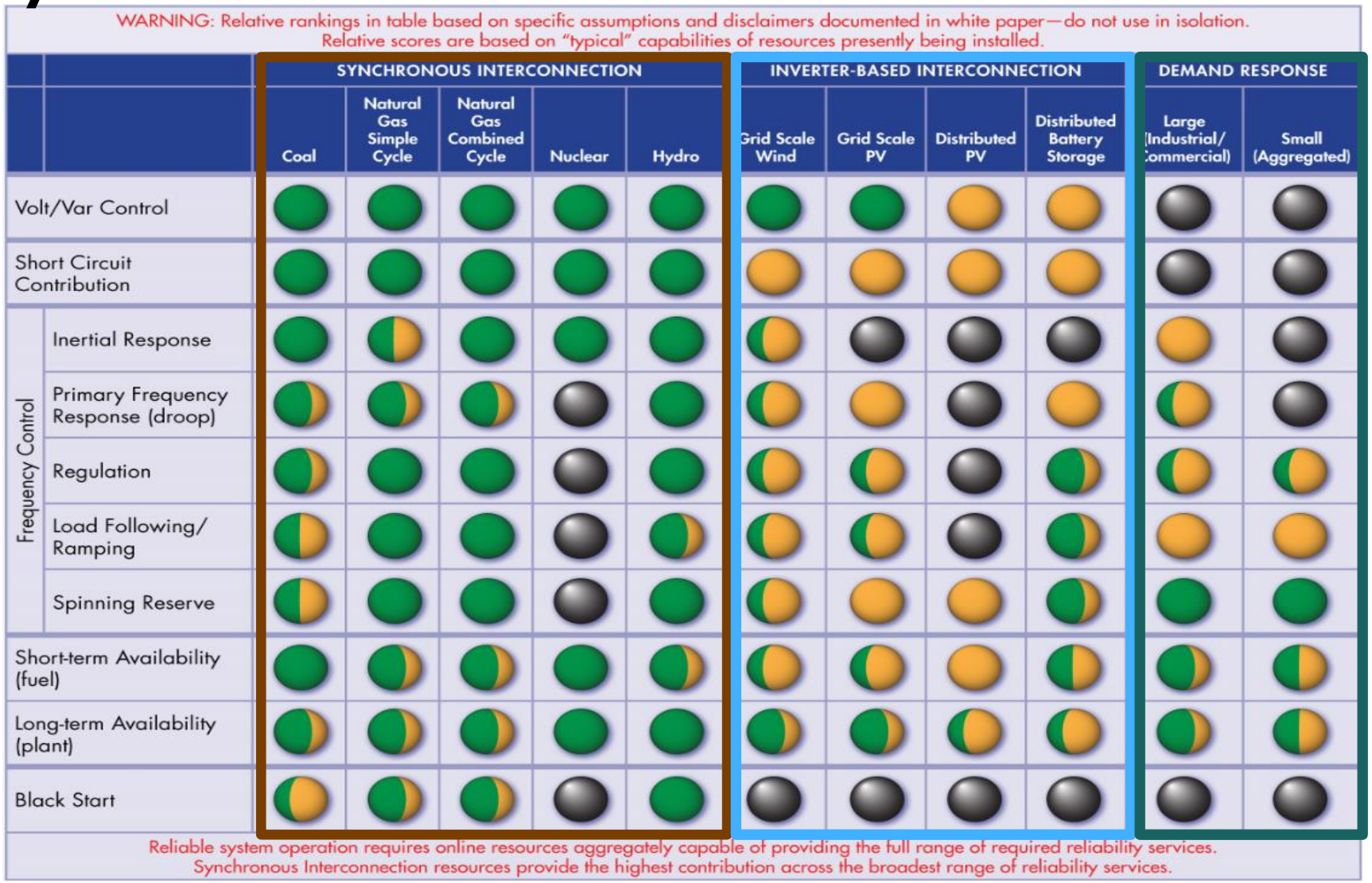
“Synthetic Inertia” from Inverter-Based Resources

Synchronous Condensers

Relative Reliability Contributions for Various Resources

- Must ensure reliability when considering new resource mix
- Not all resources are equal in “Reliability Capability”
- Synchronous resources broader & deeper ability to support reliability
- Reliability is not only consideration: Sustainability, Diversity, Economics, Emissions, among others
- Likely needs updating (2015)

EPRI whitepaper (2015): Contributions of Supply & Demand Resources to Required System Reliability Services (3002006400)



Relative score for currently installed technologies:

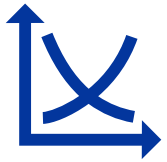
Pre-Requisites for a Reliable, Resilient Decarbonized Grid

New Grid Operation Capabilities

New protection, control, and other technologies to reliably and resiliently operate the grid

Revised Market Designs

Markets must incent investment and properly compensate resources for grid services provided



Grid Investment and Development

Adequate investment, supply chain, and workforce to develop extensive new supply, demand, and T&D resources

Efficient Regulation and Collaboration

Faster timelines for siting, permitting, and building new infrastructure and developing and deploying new technology

Integrated Planning for Reliability and Resiliency

Tools and processes for regional investment plans across electric and other energy systems in context of changing climate and other hazards