Electricity Market Visions to Support a Reliable and Affordable Electric Grid Under Decarbonization

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International Energy Agency Power Market Design Expert Workshop

21 May 2025

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

Energy Systems Integration Group:
Non-Profit Global Collaboration

ESIG

DIFFERENTIATORS

Stellar Technical Reputation | Best in Class, Global Reach | Independent and Trusted

MISSION

- Global collaboration with members based around the world
- Address the technical challenges for transforming energy systems through collaboration, education and knowledge sharing
- Collect the facts from all perspectives; share best practices via collective view points
- Work with all industries, energy vectors and applications globally
- Forward leaning, but not advocating, keeping everyone at the table
- Working at the cutting edge of the technical pathways toward 100% clean energy
- Pragmatically progressive—reliable, economic and sustainable transformation

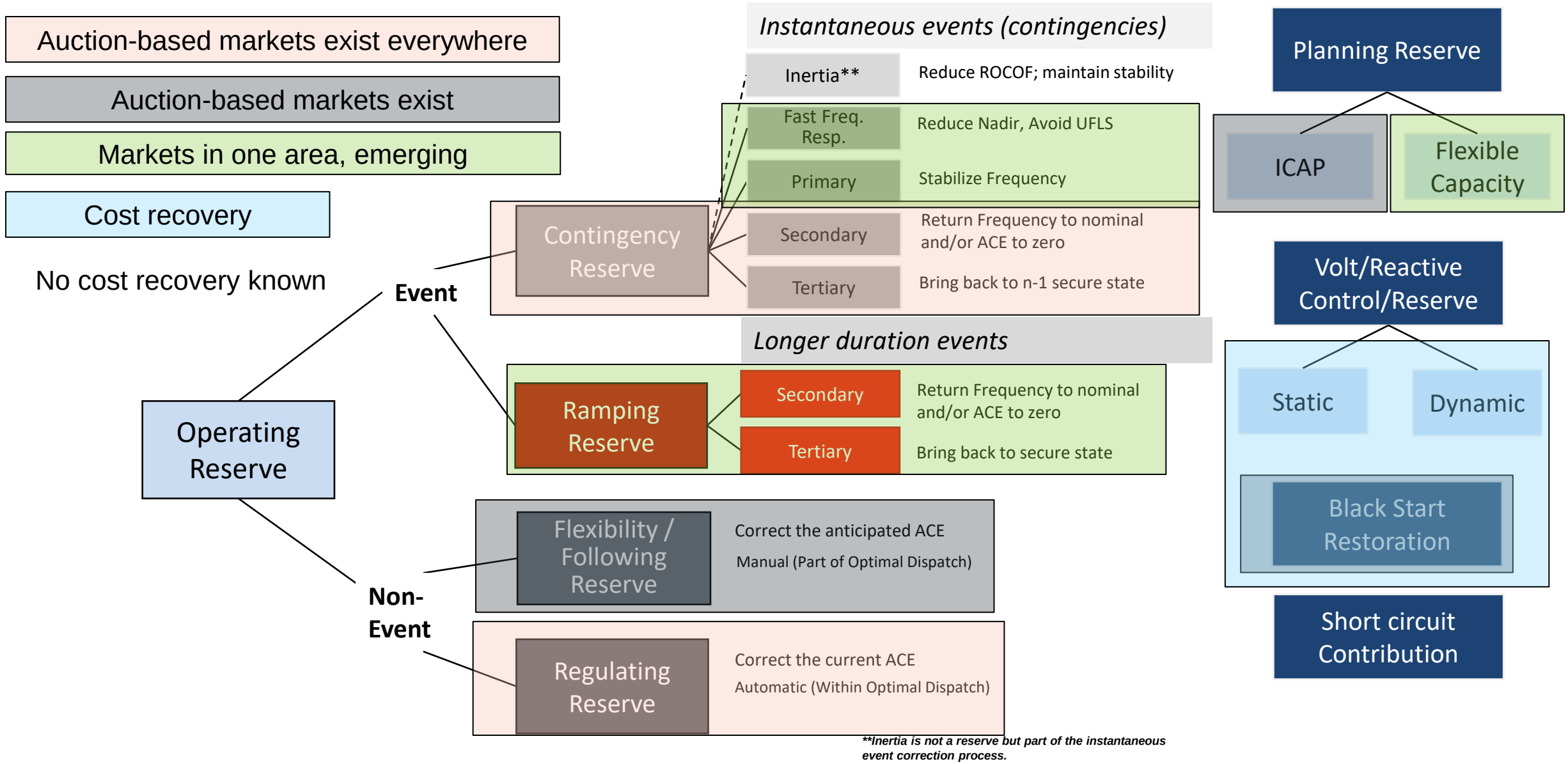
U.S. electricity market design (All)

Agent-based offers with mitigation using verified costs	Nodal pricing for suppliers	Security-constrained centralized commitment and **5-minute** centralized dispatch
Day-ahead and real-time markets for energy and ancillary services	Three-part offers, partially convexified prices	Technology-specific participation models
Co-optimized active power short-term ancillary service markets	Certain financial markets run by ISO (locational hedging and day-ahead convergence)	Reserve shortage pricing key to capital cost recovery

U.S. electricity market design (diverse designs)

Spot or forward capacity markets	Demand Response participation (and retail rules)	Ancillary Service products
Shortage pricing value and design	Mitigation Procedures	Subsidies (due to state regulation)
Reliability contribution quantification	Individual Resource or Scheduling coordinators	Real-time market horizon and process

Ancillary Services (Bulk Power System)



Adapted from Ela et al., *An Enhanced Dynamic Reserve Method for Balancing Areas,* EPRI, Palo Alto, CA: 2017. 3002010941.

Reliability Service Compensation

- Some reliability attributes are not currently incentivized:
- Sometimes auctions and market-based pricing for certain services may be impractical
- Prioritization of market design and software changes also key
  - It cost money to develop, discuss, test, implement, and administer new designs

Reasons why a market product may not be implemented	Example
Too complex to design (e.g., software complexity)	Volt/VAR support
Too specific to certain local areas (little to no competition)	Volt/VAR support
System inherently has more than sufficient amounts of the service	Synchronous Inertia
Costs for the service may be small, so cost of administrating market product may outweigh benefits	Black start (restoration) service
A specific resource requirement rather than a system-wide need	Low Voltage Ride Through

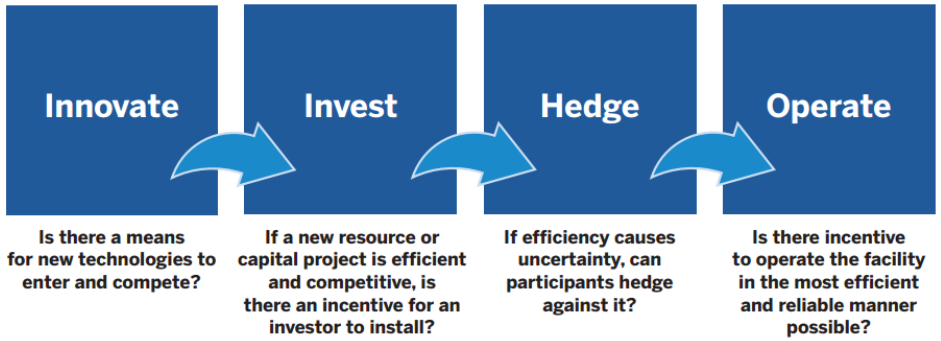
The examples are used for illustrative purposes only and the reason may not be necessarily true for each example in each region.

Complex Competitive Markets are not needed for every service!

Electricity Market Visions and Task Force

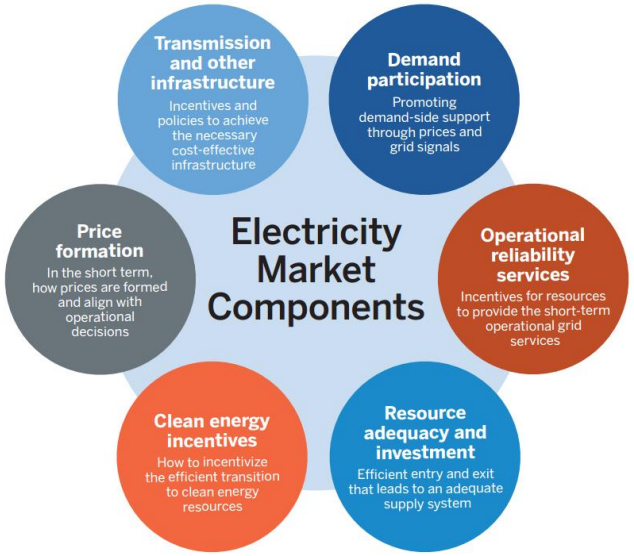
Report Link

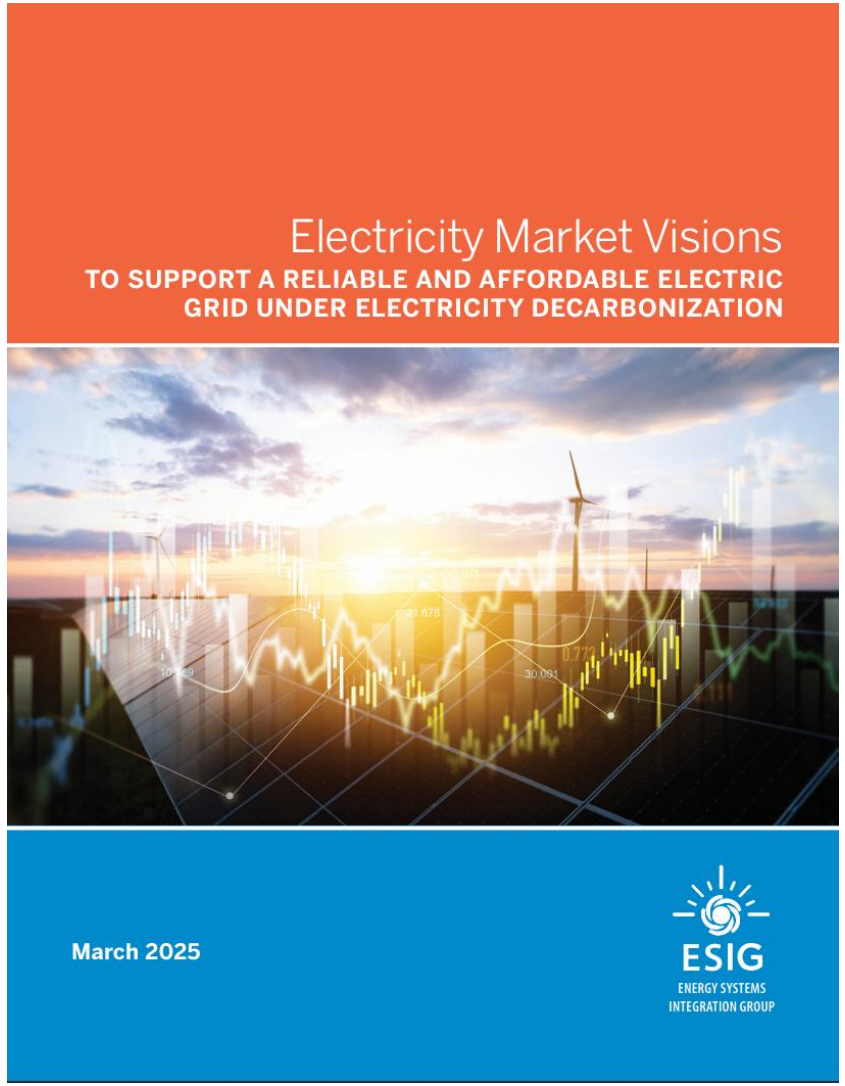
FIGURE 2
Four Key Principles That Markets Aim to Accomplish



Successful markets must incentivize innovation, investment in capital, hedging against risk, and behavior to operate in ways that lead to reliable and economically efficient outcomes.

FIGURE 1
Categories of Change for Future Market Design Vision





THANK YOU

For correspondence, questions, and future ideas, contact Erik Ela

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Additional Slides for Reference

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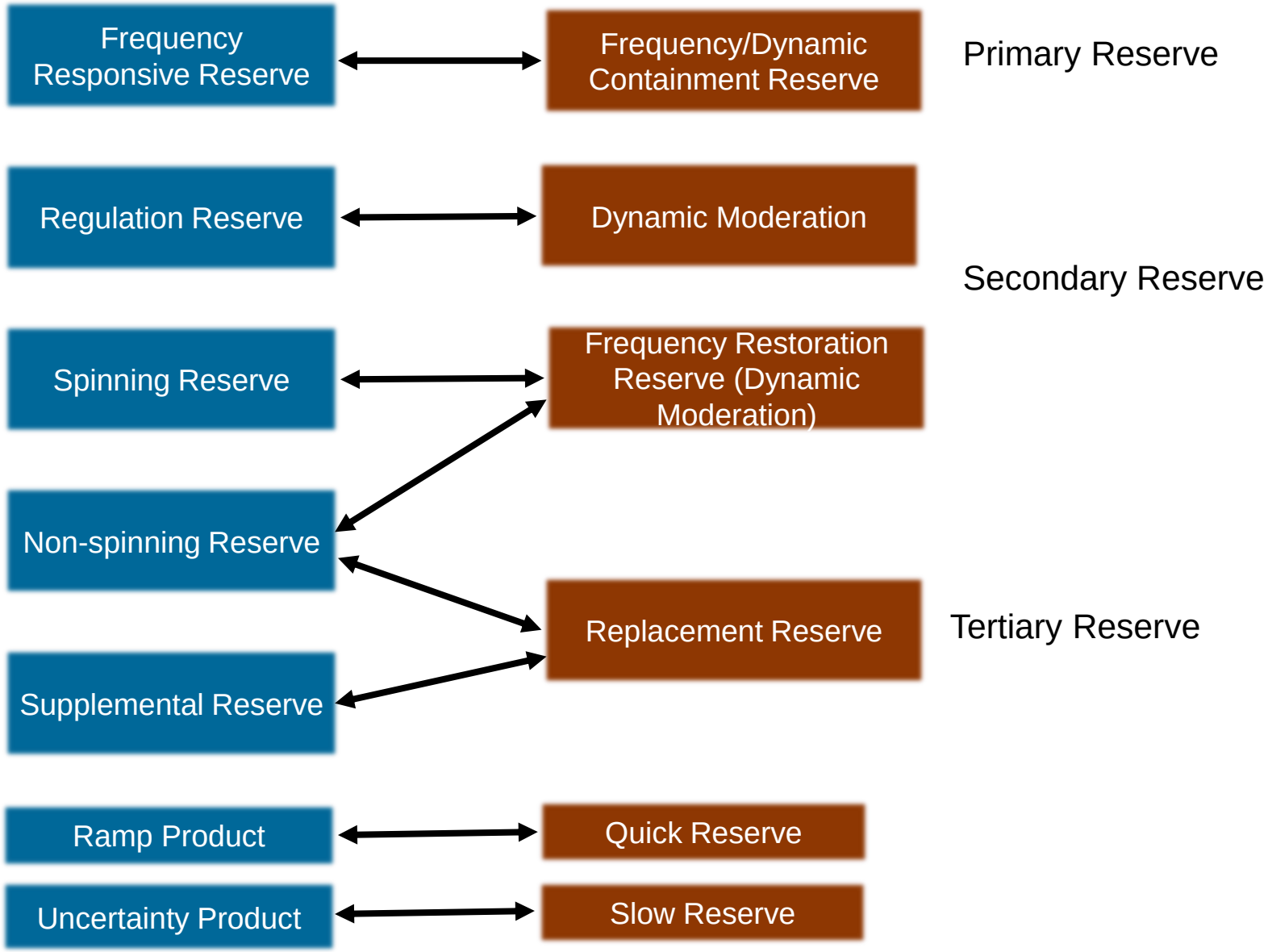
NERC ENTSO-E/UK Reserve Products Comparison



Vision Elements Summary

Price Formation

- **Incentivize to Operate**: Continue bid-based, regional markets with economic dispatch and locational marginal cost pricing
- **Incentivize to Operate and Invest**: Prices that reflect scarcity and sloped demand curves
- **Incentivize to Operate**: Incremental enhancements to improve sector coordination, seams management, scheduling tool enhancements, and exploration of more granular pricing
- **Incentivize to Innovate and Operate**: Participation Models that are preemptive, prioritized for reliability, that do not prevent or stall new competitive technologies from participation

Vision Elements Summary

Demand Participation

- **Incentivize to Operate and Innovate**: Enable greater levels of demand participation through various means including providing access to more granular prices, while protecting customer classes

Operational Reliability

- **Incentivize to Operate and Innovate:** Continuous evaluation of whether new reliability products are necessary and if competitive auctions for those products provide value that outweigh administrative cost
- **Incentiize to Operate and Invest**: Determine whether ancillary service prices derived primarily from opportunity costs are sufficient for reliability resources to invest in technologies that provide those services adequately

Vision Elements Summary

Resource Adequacy

- **Incentivize to Invest and to Hedge**: Consider additional workable mechanisms beyond energy markets through a hybrid market paradigm to allow for efficient investment
- **Incentivize to Invest and to Hedge**: Interventions may be needed for resource adequacy and certain reliability attributes

Infrastructure

- **Incentivize to Invest and to Innovate**: Consider workable policy that could incentivize innovation and efficient investment in infrastructure

Clean Energy Incentives

- **Incentivize to Invest and Innovate:** Allow markets to facilitate efficient trading of energy with efficiently designed clean energy policies accommodated through constraints or pricing
- **Incentiize to Operate and Invest**: Consider whether loads could input their willingness to purchase clean energy as a market design element for improved transparency

Relevant References

- ESIG Future Market Design Visions Paper
- Video Tutorial on Operating Reserves
- Ancillary Services in the United States: Requirements, Market Designs and Trends
- IEEE Power and Energy Magazine Issue on Zero-Marginal-Cost Electricity Markets