Resource Adequacy Trends of the Energy Transition: Experience from North America

PRESENTED BY Dr. Andrew W. Thompson PRESENTED FOR 7th Annual Capacity Mechanisms Forum Prague, Czechia

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Overview

- 1. Trends and Drivers of the Energy Transition
- 2. Capacity Markets and Mechanisms in North America
- 3. Bulk System Reliability in Tomorrow's Grid

Trends and Drivers of the Energy Transition

TRENDS AND DRIVERS OF THE ENERGY TRANSITION A changing generation mix...

Wind, Solar, and Battery Costs Falling



Customer Preferences for Clean Energy Increasing



Sources: Celebi et.al, Bulk System Reliability for Tomorrow's Grid, December 20, 2023; American Clean Power, 2022 Corporate Buyers Report, 2022.

Clean Capacity Rising (past/future)



Coal Share of Output Falling (past)



TRENDS AND DRIVERS OF THE ENERGY TRANSITION ... and increasing demand

Electric Vehicles, New Demand (e.g. data centers), and Electrification of Buildings All Increasing



Sources: Celebi et.al, Bulk System Reliability for Tomorrow's Grid, December 20, 2023; U.S. Energy Information Administration, Today in Energy, May 2019.

Increase in Electricity Demand After Decades of Decreasing Demand Growth



Capacity Markets and Mechanisms in North America

Capacity MARKETS AND MECHANISMS IN NORTH AMERICA Capacity and "energy-only" markets both use competitive prices to attract new investments in generation supply



Resource adequacy (RA) is ensured in different ways in North America

Vertically Integrated/Planned	Incremental Capacity Market	"Energy-Only" Market	Capacity Market
Vertically integrated utilities or a government entity does resource planning to build or contract new resources	Centralized procurement (utilities or government) for most RA needs paired with capacity market for incremental needs	Energy prices (plus "scarcity price" during tight hours) is primary mechanism to attract new investments	Organized market for "capacity" product is primary mechanism to attract new investments
California, SPP, *Non-RTO West, and Non-RTO East	Ontario	*ERCOT, *Alberta	PJM, ISO-NE, NYISO

Market-Based Options

*Currently undergoing reforms to resource adequacy framework

CAPACITY MARKETS AND MECHANISMS IN NORTH AMERICA

Capacity Markets and Mechanisms in North American



Increasing market expansion for energy adequacy

Increasing inter-regional trade boosts intraday flexibility

- Geographic weather and electricity demand diversity reduces impacts of wind/solar variability and reliability events across a wide area
- More seamless power sharing better leverages flexible capability of existing fleet

New markets to realize these benefits are formed or forming in the Western U.S.

- Western Energy Imbalance Market (WEIM), Formed 2014: From CAISO, intended for short-term flexibility pooling
- Western Energy Imbalance Service (WEIS), Formed 2022: From SPP, intended for short-term flexibility pooling
- Western Resource Adequacy Program (WRAP), Currently forming: From Western Power Pool and SPP, intended for resource adequacy pooling





Summary of Capacity Markets in North America



Sources and Notes: PJM, <u>Manual 18: PJM Capacity Market</u>, Revision 58. November 15, 2023, pg. 112, 158; ISO New England, <u>Reconfiguration Auctions</u>, accessed January 17th, 2024; ISO New England, <u>Market Rule 1</u>, December 5, 2023. pgs. 177 180; MISO, <u>2023/2024 Planning Resource Auction Timeline</u>, March 31, 2023; MISO, <u>Business Practices Manual: Resource Adequacy</u>, Revision 28. October 1, 2023, pg. 111; NYISO, <u>Manual 4 Installed Capacity</u> <u>Manual</u>, Version 8.0, April 27, 2023; NYISO, <u>NYISO Administered ICAP Market Auctions</u>, June 27-28, 2023; IESO, <u>Market Manual 12.0: Capacity Auctions</u>, Issue 16.0, November 29, 2023, pgs. 51-52.

Bulk System Reliability in Tomorrow's Grid



Example of shifting reliability needs (California June, 2023)



Source: North American Electric Reliability Corporation (NERC) and National Academy of Engineering (NAE), Evolving Planning Criteria for a Sustainable Power Grid, July 2024.

BULK SYSTEM RELIABILITY IN TOMORROW'S GRID

Motivation for Reforms (in the words of one U.S. policymaker): "Does the clean transition mean we just have to have blackouts?"



Characterization of Ongoing RA Reforms



Hot Topics in Resource Adequacy Reforms

- Shifting RA Planning from Capacity Adequacy to Energy Adequacy: instead of planning to meet peak load needs, shift focus to net peak load and ensuring enough energy is available across entire year
- **Resource Adequacy Accreditation:** how to determine probability of resource MWs actively contributing during reliability risk periods across all year
- Storage Dispatch in Reliability Modeling: how storage is simulated to operate during reliability risk periods greatly impacts their accreditation and, in-turn, economic attractiveness relative to other established resources
- Increasing Seasonality of RA Needs: shifting to seasonal capacity markets/mechanisms in recognition of different RA needs across seasons
- Moving to More Sophisticated RA Metrics: moving from Loss of Load Expectation (LOLE) binary eventbased metric to Expected Unserved Energy (EUE) and Loss of Load Hours (LOLH) more descriptive metrics
- How to Ensure System Stability with Less Physical Inertia: how to better incorporate inverter-based resources (renewables and batteries), design inverters to contribute to system, and provide "virtual inertia"

About the speaker



Dr. Andrew W. Thompson

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Dr. Andrew W. Thompson is an energy economist with a background in electrical engineering and expertise in wholesale electricity market design, regulatory economics, and policy analysis of network industries, particularly in the energy sector.

He supports electricity system operators, energy regulators, governments, clean energy advocacy groups, market participants, institutional investors, utilities, and other clients in several international jurisdictions including PJM, ERCOT, CAISO, MISO, NYISO, ISO-NE, Non-ISO/RTO United States, Ontario, Alberta, The United Kingdom, Ireland, Spain, Colombia, Saudi Arabia, Australia, and New Zealand.

Dr. Thompson has published thought leadership on energy policy and market reforms to integrate emerging resources (renewables, battery storage, longduration energy storage, distributed energy resources, and flexible load); the regulation of the energy sector; the evolving hydrogen economy; and the economic implications of lithium-ion battery degradation for energy storage and electric vehicle technologies.

He received a Ph.D. in Economics from the Université Paris-Saclay (France), an MS in Energy Economics from the Pontificia Universidad Comillas (Spain), an MSc. in Engineering and Policy Analysis from TU Delft (The Netherlands), and a BSc. in Electrical and Computer Engineering from Rowan University (USA).

Additional Reading

- Celebi, Levitt, Thompson, Sreenanth, <u>Bulk System Reliability for Tomorrow's Grid</u>, December 20, 2023
- Newell, Spees, Levitt, Higham, <u>MISO Reliability Attributes "Solution Space"</u>, October 4, 2023
- Celebi and Lam, <u>A Review of Coal-Fired Electricity Generation in the U.S.</u>, April 27, 2023
- Newell, Spees, and Higham, <u>Capacity Resource Accreditation for New England's Clean Energy Transition</u>, June 2, 2022
- Spees and Newell, <u>Efficiently Managing Net Load Variability in High-Renewable Systems: Designing</u> <u>Ramping Products to Attract and Leverage Flexible Resources</u>, February 2, 2022

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