

Ancillary Services in the United States: Independent System Operator (ISO) Perspective



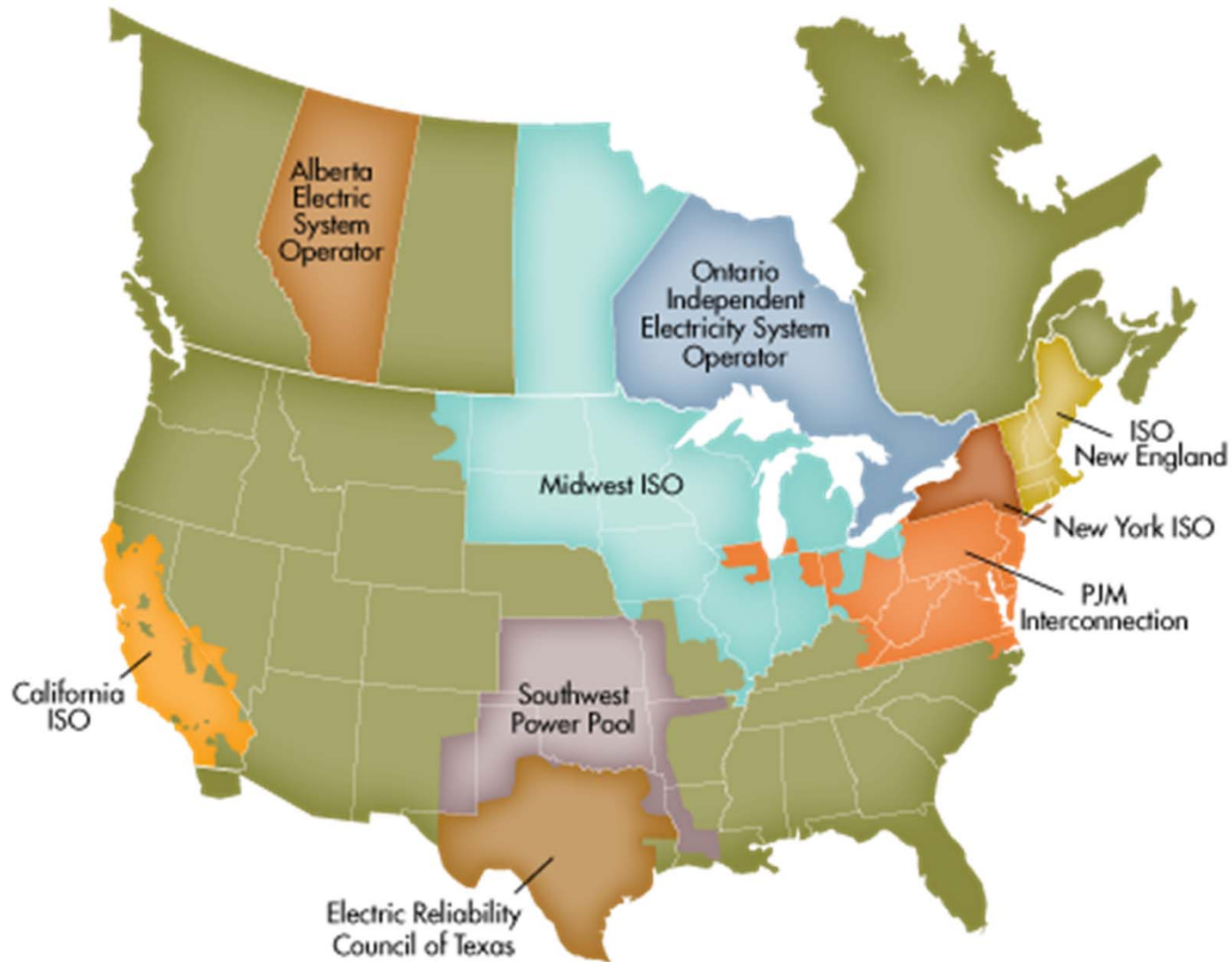
Regulatory & Policy Framework for Ancillary Services & Alternative Energy Options in the Indian Power Sector

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North American Energy Markets



Source: ISO/RTO Council

U.S. RTOs/ISOs

Market	Installed Capacity	Miles of Transmission	Population
PJM	164,895 MW	56,499	51M
MISO	146,497 MW	53,203	40M
ERCOT	88,227 MW	40,327	22M
SPP	63,000 MW	46,921	15M
CAISO	57,124 MW	25,398	30M
NYISO	40,685 MW	10,893	19M
ISO-NE	31,000 MW	8,130	14M

Source: ISO/RTO Council

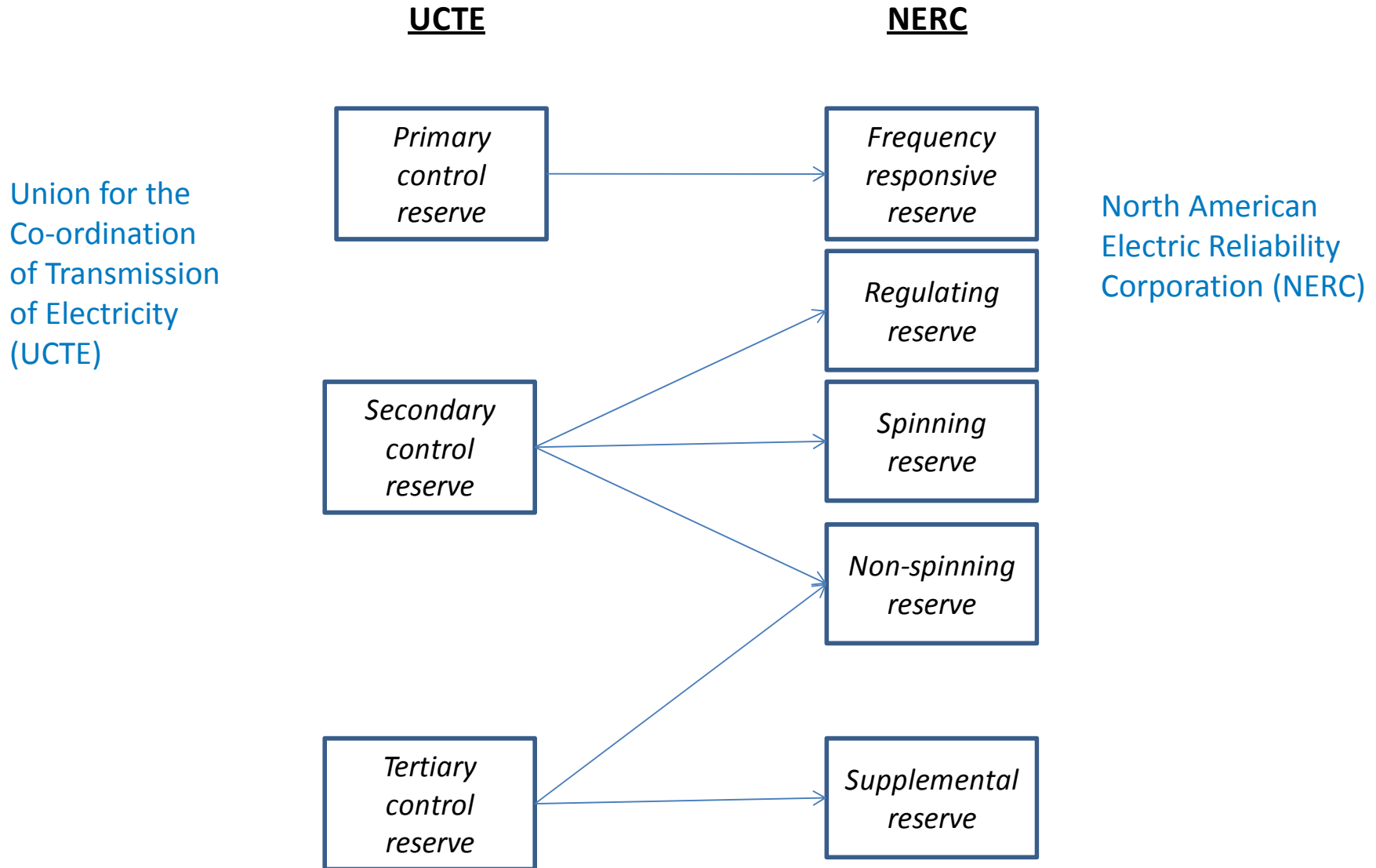
Current Market Types

- Day-Ahead Energy Market
- Real-Time Energy Market
- Ancillary Services Market
- Financial Transmission Rights Markets
- Capacity Markets

Ancillary Services

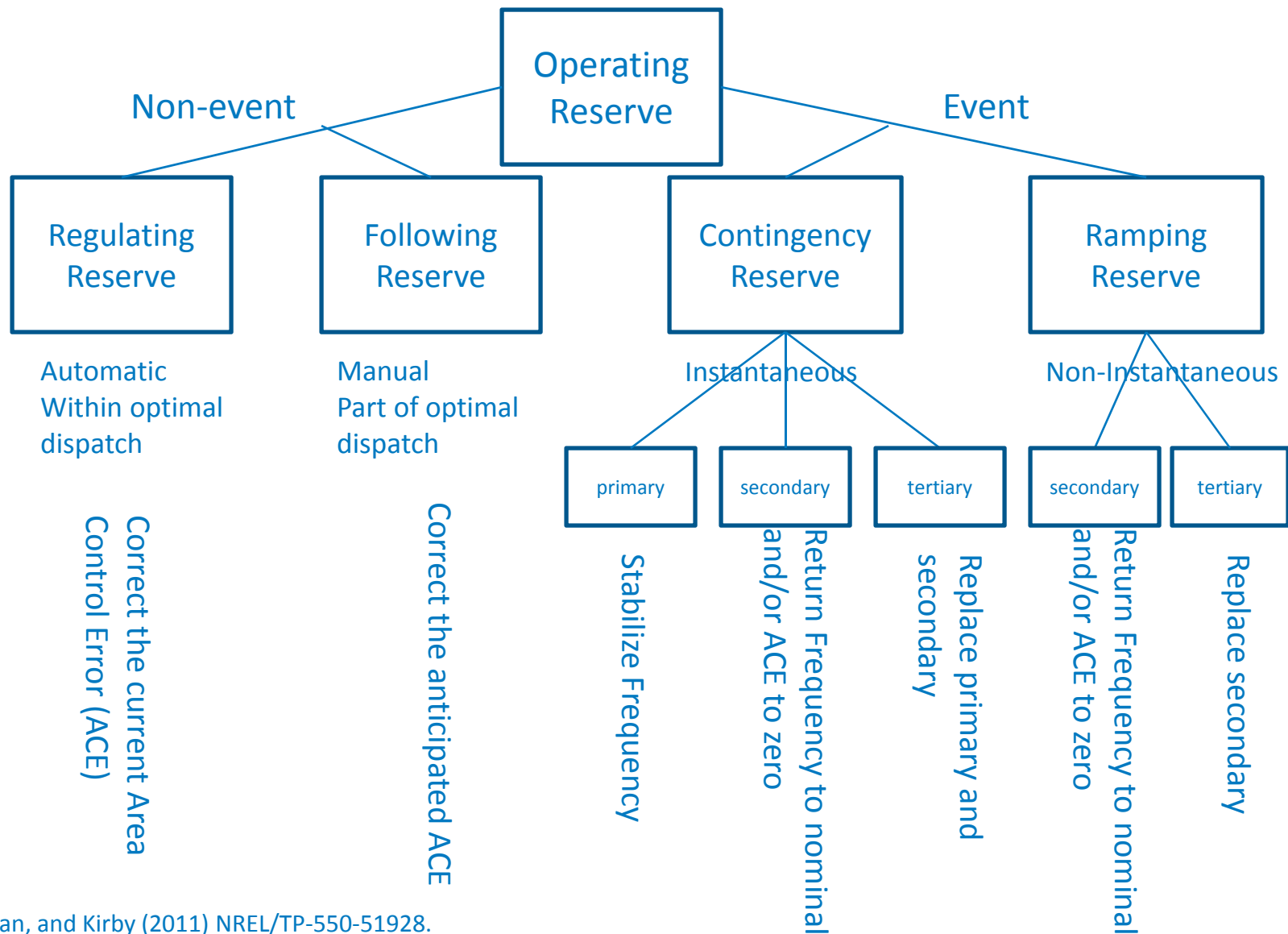
- Ancillary services can either be cost-based or market-based
 - Markets: regulating and contingency reserves, load following/energy imbalance
 - Cost-based mechanisms: voltage support and black start capability
- ISO sets the required amount of ancillary services and chooses the least cost option to supply it
- Many areas will co-optimize the ancillary services with energy to obtain an overall least cost solution
- Prices reflect marginal cost to provide service, which includes availability cost & lost opportunity cost

Taxonomy of Ancillary Services



Source: Erik Ela, NREL

Operating Reserve Categorization



Why Create Competitive Markets for Ancillary Services?

- Costs to provide services are not trivial
- Services are primarily generation, and generation is competitive
- Generators differ in capabilities (speed, accuracy)
- Markets allow diverse suppliers
- Allows load to participate in supplying services

Source: Brendan Kirby (2012)

Ancillary Service Prices in the US

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Annual Average \$/MW-hr										
California (Reg = up + dn)										
Regulation	26.9	35.5	28.7	35.2	38.5	26.1	33.4	12.6	10.6	16.1
Spin	4.3	6.4	7.9	9.9	8.4	4.5	6.0	3.9	4.1	7.2
Non-Spin	1.8	3.6	4.7	3.2	2.5	2.8	1.3	1.4	0.6	1.0
Replacement	0.90	2.9	2.5	1.9	1.5	2.0	1.4			
ERCOT (Reg = up + dn)										
Regulation		16.9	22.6	38.6	25.2	21.4	43.1	17.0	18.1	31.3
Responsive		7.3	8.3	16.6	14.6	12.6	27.2	10.0	9.1	22.9
Non-Spin		3.2	1.9	6.1	4.2	3.0	4.4	2.3	4.3	11.8
New York (east)										
Regulation	18.6	28.3	22.6	39.6	55.7	56.3	59.5	37.2	28.8	11.8
Spin	3.0	4.3	2.4	7.6	8.4	6.8	10.1	5.1	6.2	7.4
Non Spin	1.5	1.0	0.3	1.5	2.3	2.7	3.1	2.5	2.3	3.9
30 Minute	1.2	1.0	0.3	0.4	0.6	0.9	1.1	0.5	0.1	0.1
MISO (day ahead)										
Regulation								12.3	12.2	10.8
Spin								4.0	4.0	2.8
Non Spin								0.3	1.5	1.2
New England (Reg + "mileage")										
Regulation			54.6	30.2	22.7	12.7	13.8	9.3	7.1	7.2
Spin					0.3	0.4	1.7	0.7	1.8	1.0
10 Minute					0.1	0.3	1.2	0.5	1.6	0.4
30 Minute					0.0	0.1	0.1	0.1	0.4	0.3

Source: Brendan Kirby (2012)

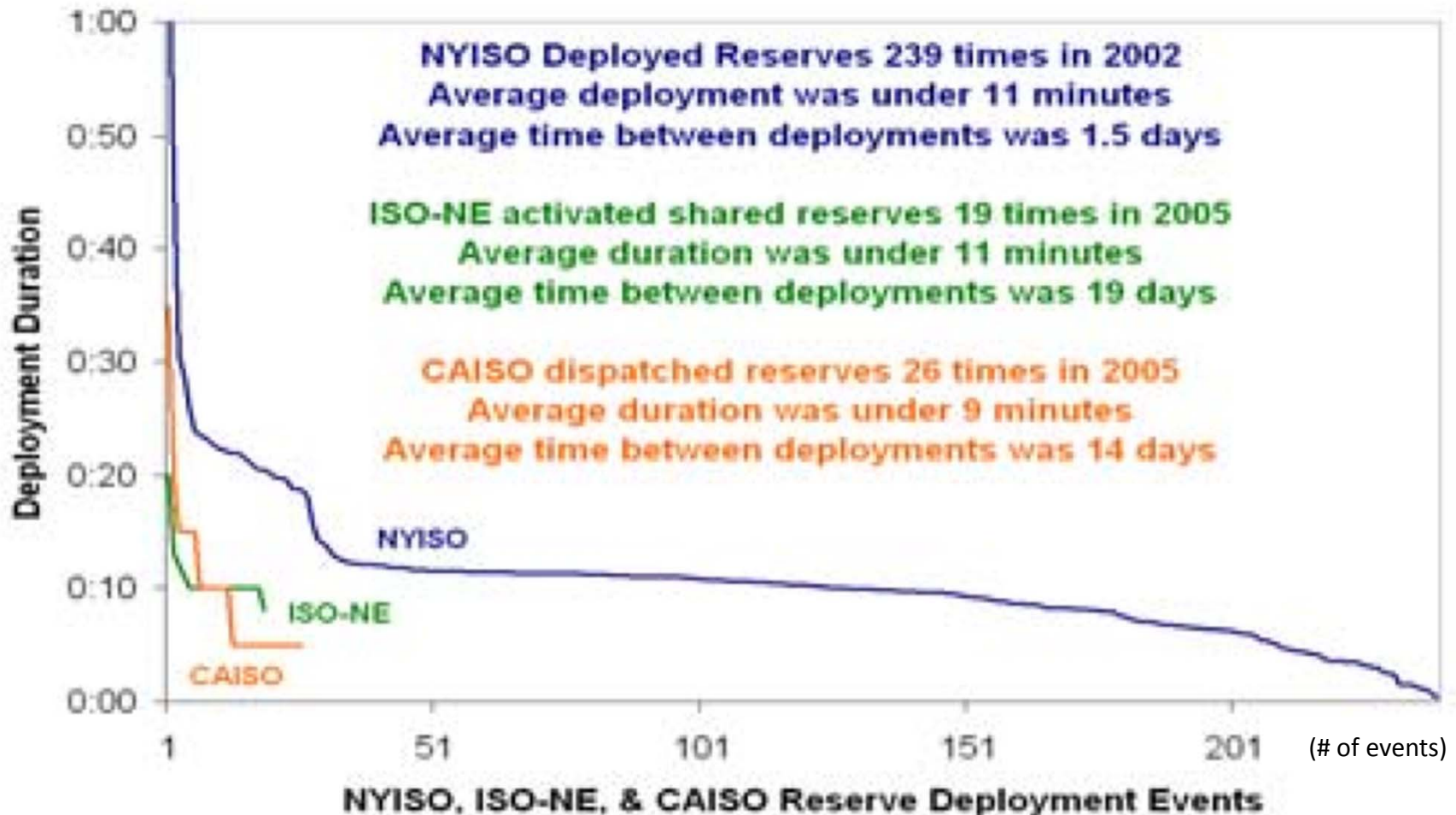
Regulating Reserves



Region	Separate/ Combined	Rule
PJM	Combined	Based on 1% of the peak load during peak hours and 1% of the valley peak during off-peak hours.
NYISO	Combined	Set requirement based on weekday or weekend, hour of day, and season.
ERCOT	Separate	Based on 98.8th percentile of regulation utilized in previous 30 days of same month of previous year and adjusted by installed wind capacity.
CAISO	Separate	Use a requirement floor of 350-MW up and down regulating reserves which can be adjusted based on load forecast, must-run instructions, previous CPS performance, and interchange and generation schedule changes.
MISO	Combined	Requirement made once a day based on conditions before the day-ahead market closes.
ISO NE	Combined	Based on month, hour of day, weekday/sat/sun.

Source: Erik Ela, NREL (2012)

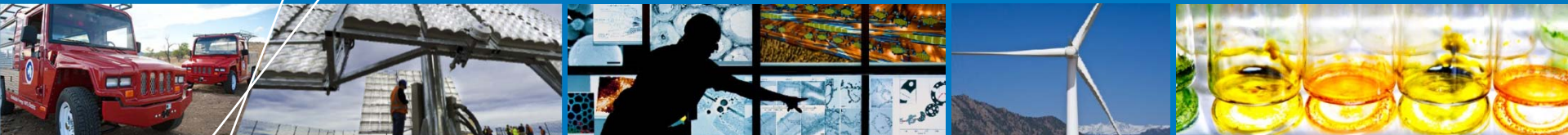
ISOs Differ in the Frequency of their Deployment of Contingency Reserves



Source: Brendan Kirby (2012)

New Participants in Ancillary Services Markets

- Wind and solar
- Demand response
- Storage
- Distributed generation



Thank you!

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