RTOs, wholesale markets, and decarbonization

ESIG Fall Technical Workshop

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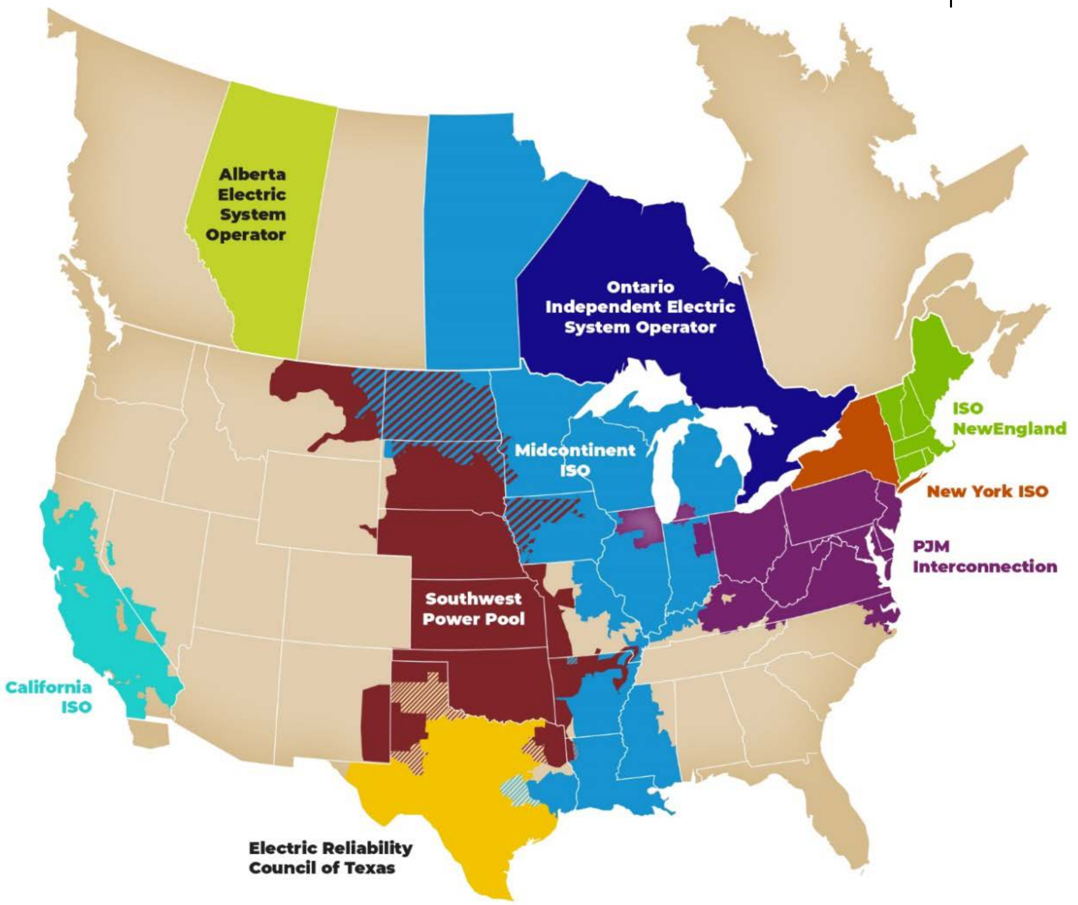
Outline

- Some background on ISOs and phases of ISO market evolution
- The current phase of state policies affecting markets
- The push to decarbonization and some issues for the next ten years

US and Canadian ISOs and EIM



EIM

Source: ISO/RTO Council

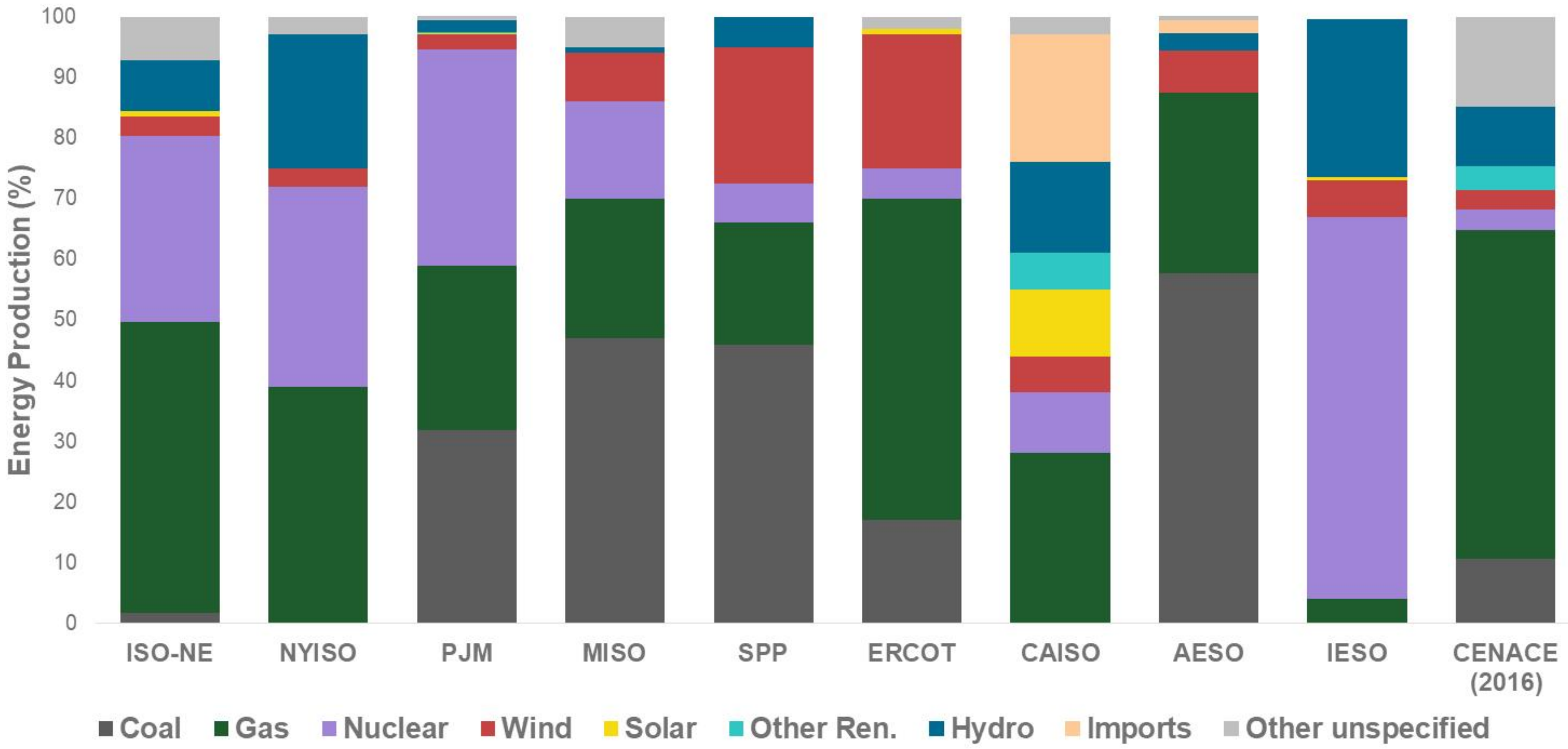
Source: CAISO

System Characteristics of North American ISOs, 2017

	2017 Peak Load (MW)	Historical Peak Load (MW) and date	Total Generation Capacity (GW)	Generating Units	Annual Energy (TWh)	Transmission (Miles)
AESO	11,473	11,473 (12-28-17)	17	384	82.6	16,000
CAISO	50,116	50,270 (7-24-06)	60	1,080	230-260	26,000
CENACE (2016)	40,893	46,813 (06-06-18)	74	700	298.8	33,000
ERCOT	69,512	71,110 (08-11-06)	103	610	340-357	46,500
IESO	21,786	27,005 (08-01-06)	37	171	132.1	18,600
ISO-NE	23,968	28,130 (08-02-06)	31	350	120-135	9,000
MISO	120,600	127,125 (07-20-11)	175	1,400	600-680	65,800
NYISO	29,699	33,956 (07-19-13)	41	760	155-165	11,173
PJM	146,000	165,492 (Summer ’06)	179	1,400	770-840	84,000
SPP	51,181	51,181 (07-20-17)	87	795	225-266	66,497

Source: EPRI 2018

Fuel mix of North American ISOs and RTOs, by percentage (%) of total annual energy, 2017



Source: EPRI 2018

Data on total market financial settlements (2017 unless otherwise indicated)

	Total Market Volume ($B)	All-in-Price ($/MWh)	Energy ($B)	Ancillary Services Markets ($M)	Uplift ($M)	Financial Transmission Rights ($M)	Capacity Market ($M)
AESO*	3	25.5	1.8	81	0.23	N/A	N/A
CAISO	9.3	42	8.7	172	108	80	N/A
ERCOT	14	30.15	10	323	0.5	379	N/A
IESO*	17	15.8	2.2	57	146	N/A	N/A
ISO-NE	9.1	76	4.5	128	52	30	2,240
MISO	26.9	31.35	24.7	69	104	252	47
NYISO	8.7	40	5.3	110	38	222	3,000
PJM	40.0	54	23.5	508.1	129	542	8,800
SPP	16.7	24.08	6.3	80	68	308.8	N/A

Source: EPRI 2018

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Phases of ISO development

Phase 1 – initial market start-ups and lessons learned	
1996	FERC Order 888; principles for ISO formation
1998-99	Initial start-ups (PJM, ISO-NE, NYISO, CAISO) with different market designs; FERC Order 2000 (1999) characteristics and functions of an RTO
2000-01	California power crisis
2002	FERC Standard Market Design (terminated)
Phase 2 – market expansion and convergence in designs	
2003-05	2003 - ISO-New England converts to LMP, beginning of MISO operations; centralized energy markets with LMP begin in 2005
2009-10	California (2009) and ERCOT (2010) begin LMP market
2014	SPP begins LMP market
Phase 3 – adaptation to clean energy policies and new technologies	
Several major FERC Orders on clean technologies, Orders 745 and 755 (2011), Order 764 (2012), Order 841 (2018); states increase renewable and clean energy policies	
Phase 4 – very high renewables/decarbonization?	

Chapter 19

RTOs, Regional Electricity Markets, and Climate Policy

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Abstract

This chapter examines how policies to mitigate greenhouse gas (GHG) emissions from the electric power sector could affect the core functions of the Regional Transmission Organizations (RTOs) that encompass approximately two thirds of the U.S. power system. Following a review of policy options for emissions abatement and their general implications for

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2010 survey book chapter

General features of ISO/RTO markets, operations and planning functions which <u>facilitate</u> clean energy development and participation

- Convergence to energy markets with security constrained unit commitment and economic dispatch and LMP, co-optimization of energy and reserves
- Regional/inter-regional scope for markets and planning
- Continued improvements in operational control and market coordination between ISOs and neighboring market or non-market systems
- Advanced optimization methods for large numbers of resources, some of which can be flexibly adapted to new types of resources
- Improvements in forecasting and other aspects of system operations; many advances in control rooms
- Fairly rapid incremental modifications of market products and pricing in response to market and reliability needs and regulatory requirements (usually 1-2 years); more significant market design changes can take longer

General features of ISO/RTO markets, operations and planning functions which <u>may hinder</u> clean energy development and participation

- Market complexity
- Lack of standardization in market rules and operational practices between ISOs
- Some market design flaws or other problems which may take years to resolve; almost continuous changes to some ISO market product designs
- Insufficient or ad hoc data on existing resource mix and attributes, which entities are market money in which market products
- Lags in development of market participation models and optimization methods for some new resource types, or efficient operation of older clean resources (e.g., pumped storage)
- Uncertainty over the capacity contributions of new resource types (e.g., wind/solar ELCCs)
- Wide variation between ISOs in wholesale market integration of DR/DER

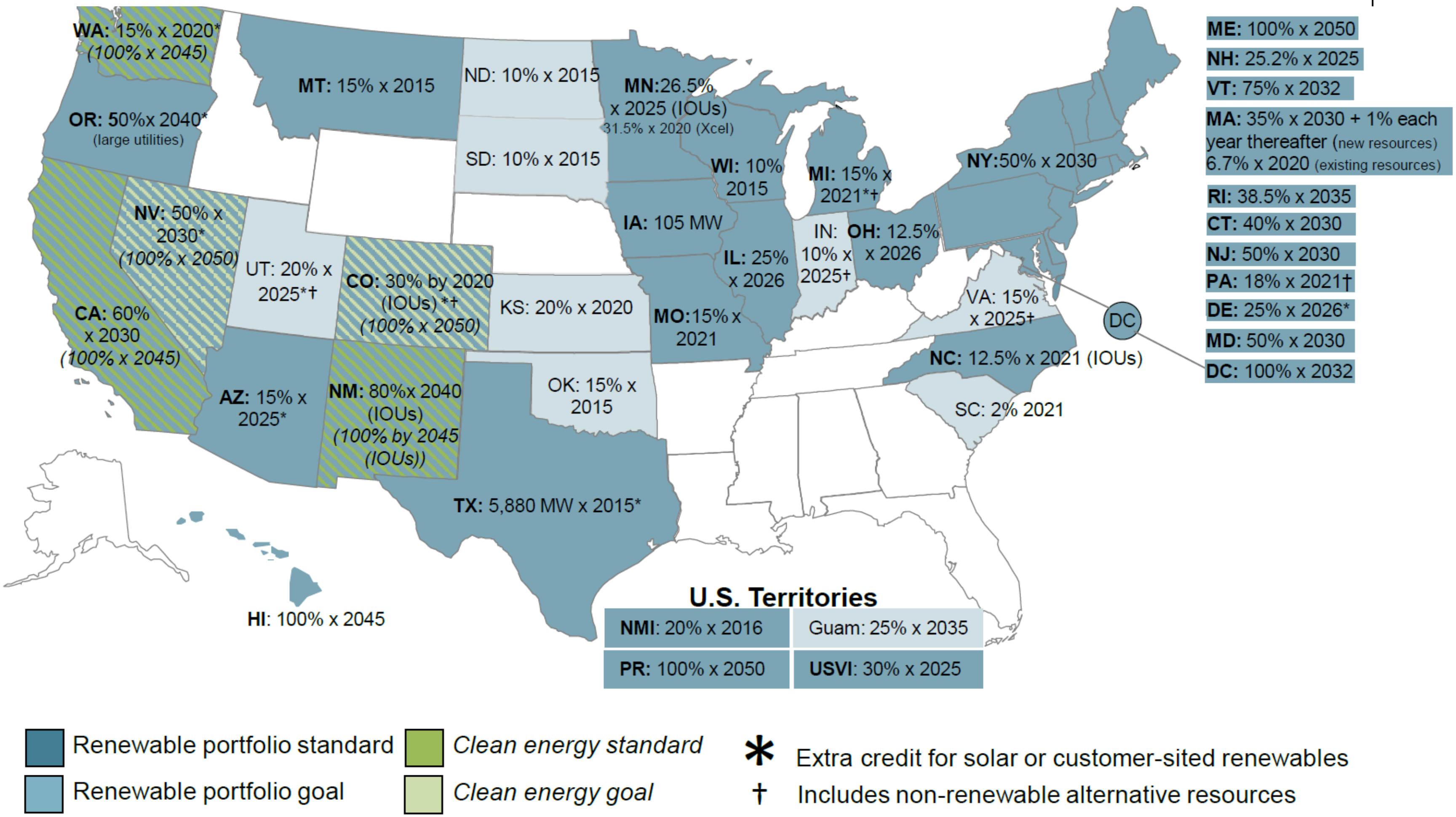
The ideal "price-driven" policy consistent with competitive wholesale markets

- Carbon tax or Greenhouse Gas (GHG) cap-and-trade system, regional or national in scope (see, e.g., carbon pricing studies of PJM, New York)
- Utilize other policy interventions minimally to develop and mature new technologies (e.g., RPS, direct subsidies)
- Wholesale market designs for energy, ancillary services and capacity adapted to changing system needs and to facilitate entry of new types of resources
- Regional market development coupled with efficient transmission expansion
- Let forward (off-ISO) markets determine appropriate bilateral contract terms

Why have state regulators in ISO/RTO regions not followed this path?

- Lack of federal policy on greenhouse gas mitigation has prompted growing number of state policy initiatives based on direct regulation – RPS/CES, storage policies, NEM and other subsidies for distributed resources
- Difficulty of state coordination on carbon pricing in regional interconnections; “leakage” concerns if policies are different between states/subregions
- Concern about reaction of wholesale and retail customers to increased costs of electric power and transportation fuels
- Desire for control over policy/regulatory levers for resource entry and exit; mistrust of market-based mechanisms under federal jurisdiction which don’t reflect those preferences

State RPS and CES targets



Source: DSIRE, 2019

ISO responses to state clean energy policy initiatives

- Many levels of ISO adaptation to state policies and changes to resource mix, with major variations by region; interesting similarities and differences
- Some drivers of differences in ISO approaches include:
  - Whether one-state or multi-state ISO/RTO
  - Whether states pursued restructuring and retail competition or not, and current status
  - Market "philosophy" of ISO and/or major states in region; desire for continued role of wholesale markets to guide investment
  - Energy and environmental policy interests of major states in region; the competition for state leadership
  - Resource mix in ISO and reliability/operational requirements

ISO responses to state clean energy policy initiatives

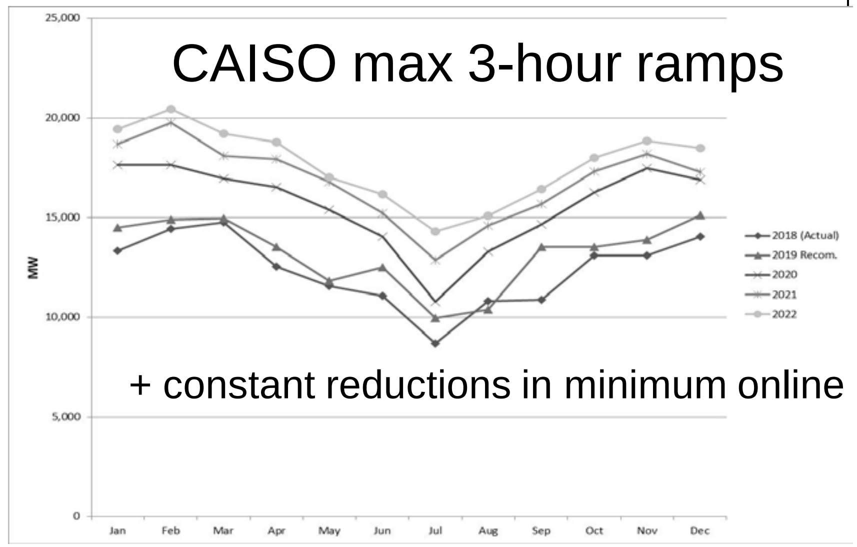
- NYISO and ISO-New England have states with low penetration of renewables, DER and new storage, but want to rapidly increase deployment using policies
  - Initial phases - ISOs adapting capacity markets to incorporate resources with subsidies without direct participation (e.g., ISO-NE Competitive Auctions with Sponsored Policy Resources (CASPR))
  - ISOs and states evaluating carbon pricing as alternative driver of decarbonization and achievement of state objectives; final direction not yet clear
- Similarly, PJM is beginning from very low renewable participation but has otherwise encountered pressures for states to take resources out of the market or subsidize them within the market; PJM is attempting to maintain the role of wholesale markets in driving investment; continues to resist subsidized resources in capacity market; has done some evaluation of carbon pricing and regional renewable integration; but states are starting to announce major renewable targets/projects based on policies

ISO responses to state clean energy policy initiatives

- MISO and SPP have high wind penetration due to a combination of state policies and federal tax incentives; Minnesota is advancing state policy initiatives; region remains largely vertically integrated
- ERCOT – emphasis on energy market price formation and continuation of wholesale and retail competition; support for wind development with transmission expansion; but other new technology solutions (e.g., storage as T&D assets) have been pushed back due to concerns about energy market impacts
- CAISO – California has advanced furthest to policy-driven procurement (transitioning to IRP-driven resource selection), CAISO has primarily focused on local reliability and adaptation of system operations and markets; Resource Adequacy program largely handled by CPUC with technical support from CAISO; no consideration of impact on wholesale market in any state policies

Many success stories

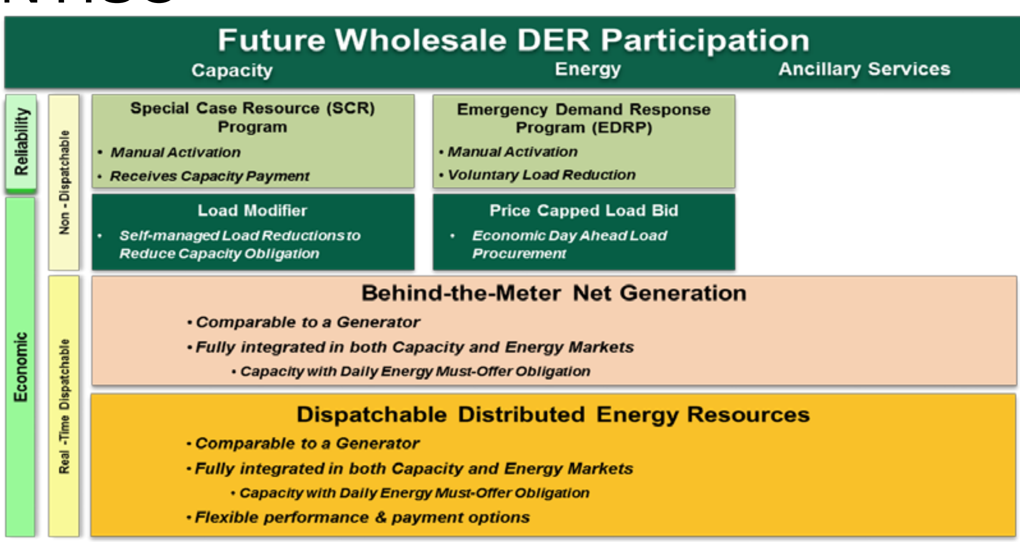
Region	Country	Instantaneous Penetration of Asynchronous Generation as a Percentage of Load	Annual Penetration of Asynchronous Generation as a Percentage of Load	Peak Load (MW)
CAISO	United States	49% (2017)	27% (2016)	46,232 (2016)
Denmark	Denmark	140% (2015)	42% (2015)	6,000 (2013)
EirGrid	Ireland	60% (2017)	22% (2016)	4,700 (2016)
ERCOT	United States	50% (2017)	15% (2016)	71,000 (2016)
MISO	United States	22% (2016)	8% (2016)	120,700 (2016)
Portugal	Portugal	104% (2015)	23% (2015)	8,300 (2015)
South Australia Grid	Australia	119% (2016)	35% (2016)	2,895 (2016)
Southwest Power Pool	United States	52% (2017)	14% (2015)	50,083 (2016)

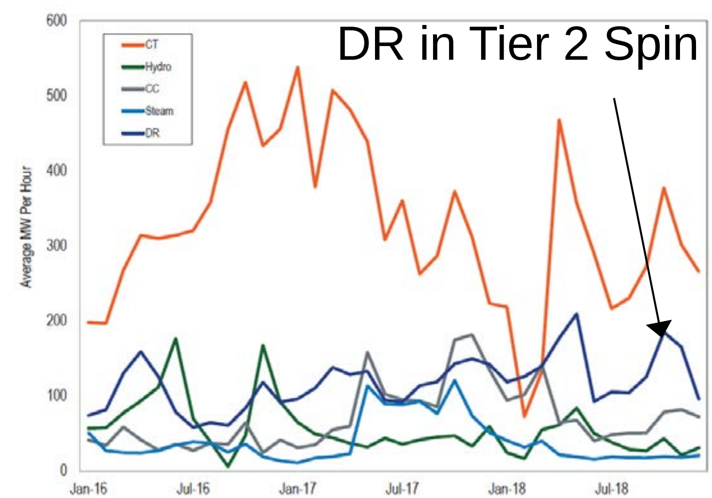


PJM

Year	Avg. Battery revenue ($/MW of Regulation provided)	Battery share of market (%)
2014	$36.78	16
2015	$27.07	27.6
2016	$15.39	41
2017	$28.25	30
2018	$33.21	21.2

NYISO





Some factors which will affect the future pathways of ISOs and wholesale markets

- If California reaches electric power decarbonization first, will it encourage other states to follow the mandated policy-driven path even faster?
- Will state policies fragment the multi-state ISO/RTO markets?
- Will any ISO implement carbon pricing? Otherwise, will certain wholesale markets develop prices which are so volatile and/or depressed that market participants exit?
- What will be the impact on markets, operations and planning of significant expansion in behind-the-meter DER?
- Will ISOs efficiently manage exit of reliability resources losing revenues, or reach limits and increase reliance on “out of market” contracts – e.g., RMR-type contracts – or significantly redesigned RA contracts – e.g., for very long-duration capacity resources?
- Is there a need or opportunity for further market design reforms in particular ISOs or additional federal market design initiatives?

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Udi Helman, Ph.D. is a consultant on electricity markets and emerging technologies. He worked for almost 10 years on wholesale market design at the Federal Energy Regulatory Commission (FERC) in Washington, D.C. (1997-2007), where he was involved in several ISO market starts and transitions, the standard market design initiative, and long-term transmission rights. After that, he was a Principal focused on market design and policy analysis at the California Independent System Operator (CAISO) (2007-2010). In recent years, he has also worked on emerging technologies, in particular renewable energy and energy storage. Among many publications, he has authored and co-authored papers published in books, research reports, and peer-reviewed journals on aspects of wholesale market design, as well simulation modeling of renewables and storage technologies. His Ph.D. is in applied economics and systems analysis from The Johns Hopkins University.

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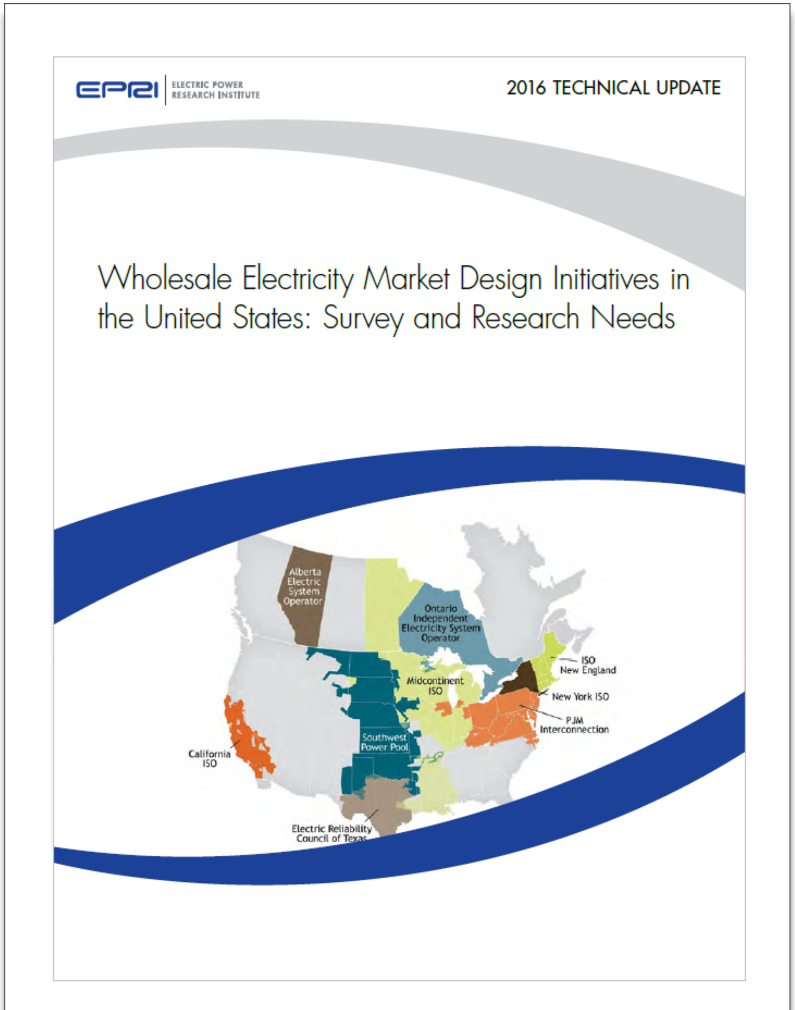
References to figures and tables: EPRI Wholesale Electricity Market Design surveys (2016 and 2018)



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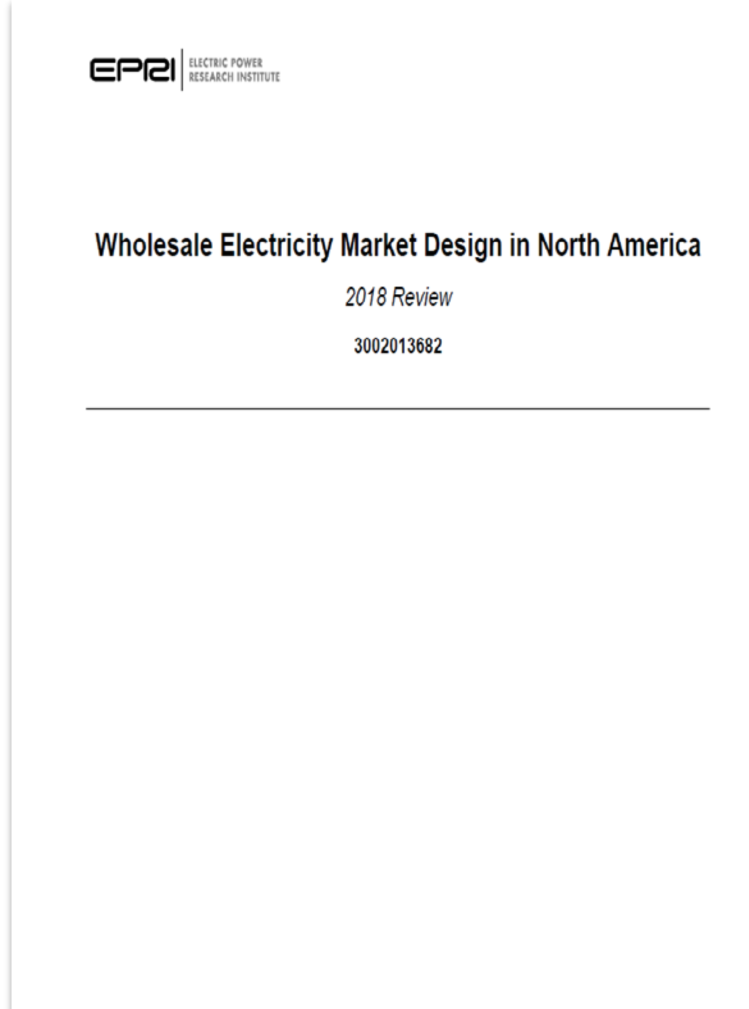
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Wholesale Electricity Market Design in North America

2018 Review

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