Table of Contents		Overview: Section 12, Planning	77
Table of Contents		Overview: Section 13, FTRs and ARRs	88
Preface	i		
CDCDON A DATE OF THE PARTY OF T		SECTION 2 Recommendations	95
SECTION 1 Introduction	1	Recommendation Priority	95
2024 Q1 in Review	1	Recommendation Status	95
PJM Market Summary Statistics	6	New Recommendations	96
PJM Market Background	6	Complete List of Current MMU Recommendations	96
Conclusions	8	Section 3, Energy Market	96
Energy Market Conclusion	8	Section 4, Energy Uplift	101
Capacity Market Conclusion	10	Section 5, Capacity Market	102
Synchronized Reserve Market Conclusion	11	Section 6, Demand Response	106
Nonsynchronized Reserve Market Conclusion	12	Section 7, Net Revenue	109
Secondary Reserve Market Conclusion	12	Section 8, Environmental and Renewables	109
Regulation Market Conclusion	12	Section 9, Interchange Transactions	110
FTR Auction Market Conclusion	13	Section 10, Ancillary Services	111
Role of MMU	14	Section 11, Congestion and Marginal Losses	113
Reporting	14	Section 12, Planning	113
Monitoring	14	Section 13, FTRs and ARRs	115
Market Design	15		
New Recommendations	16		
Total Price of Wholesale Power	16	SECTION 3 Energy Market	119
Components of Total Price	16	Overview	121
Section Overviews	20	Supply and Demand	121
Overview: Section 3, Energy Market	20	Competitive Assessment	123
Overview: Section 4, Energy Uplift	32	Recommendations	124
Overview: Section 5, Capacity Market	37	Conclusion	129
Overview: Section 6, Demand Response	49	Supply and Demand	133
Overview: Section 7, Net Revenue	57	Market Structure	133
Overview: Section 8, Environmental and Renewables	58	Market Behavior	148
Overview: Section 9, Interchange Transactions	63	Generator Offers	148
Overview: Section 10, Ancillary Services	66	ICAP Must Offer Requirement	149
Overview: Section 11, Congestion and Marginal Losses	76	Emergency Maximum MW	150

Parameter Limited Schedules	151	Uplift Eligibility	290
Virtual Offers and Bids	158	Energy Uplift Issues	297
Market Performance	168	Uplift Resettlement	297
LMP	168	Uplift Forfeiture Rule	297
Zonal LMP and Dispatch	193	Regulation Market Offsets	297
Fuel Prices, LMP, and Dispatch	200	Intraday Segments Uplift Settlement	298
Components of LMP	209	Concentration of Energy Uplift Credits	299
Shortage	214	Uplift Credits and Market Power Mitigation	300
Emergency Procedures	214	Fast Start Pricing	30
Power Balance Constraint Violation	218	Winter Storm Gerri (January 13 - 22, 2024)	303
Shortage and Shortage Pricing	219		
Competitive Assessment	228		
Market Structure	228	SECTION 5 Capacity Market	305
Market Behavior	234	Overview	307
Market Performance	262	RPM Capacity Market	307
Market Structure, Participant Behavior, and Market Performance	273	Part V Reliability Service (RMR)	309
		Generator Performance	309
	075	Recommendations	309
SECTION 4 Energy Uplift (Operating Reserves)	275	Conclusion	313
Overview	276	Installed Capacity	320
Energy Uplift Credits	276	Fuel Diversity	32
Energy Uplift Charges	276	RPM Capacity Market	323
Geography of Charges and Credits	277	Market Structure	323
Recommendations	277	Market Conduct	339
Conclusion	278	Market Performance	34!
Energy Uplift Credits	281	FRR	350
Categories of Credits and Charges	282	CRF Issue	35
Types of Units	284	Timing of Unit Retirements	353
Day-Ahead Unit Commitment for Reliability	285	Part V Reliability Service	35!
Balancing Operating Reserve Credits/Balancing Generator Credits	287	Generator Performance	358
Lost Opportunity Cost Credits	289	Capacity Factor	358
Energy Uplift Charges	292	Generator Performance Factors	359
Energy Uplift Charges	292	Generator Outage Rates	362
Operating Reserve Rates	294	Generator Testing Issues	367
Reactive Services Rates	295		

iv Table of Contents © 2024 Monitoring Analytics, LLC

SECTION 6 Demand Response	371	SECTION 8 Environmental and Renewable Energy	y
Overview	371	Regulations	437
Recommendations	372	Overview	437
Conclusion	375	Federal Environmental Regulation	437
PJM Demand Response Programs	378	State Environmental Regulation	439
Non-PJM Demand Response Programs	380	State Renewable Portfolio Standards	439
PJM Demand Response Programs	380	Emissions Controls in PJM Markets	439
Emergency and Pre-Emergency Load Response Programs	381	Renewable Generation	440
Economic Load Response Program	396	Recommendations	440
Energy Efficiency	406	Conclusion	440
Peak Shaving Adjustment	411	Federal Environmental Regulation	442
		CAA: NESHAP/MATS	443
		CAA: NAAQS/CSAPR	443
SECTION 7 Net Revenue	413	CAA: NSR	44!
Overview	413	CAA: RICE	44!
Net Revenue	413	CAA: Greenhouse Gas Emissions	440
Recommendations	413	CWA: WOTUS Definition and Effluents	447
Conclusion	413	RCRA: Coal Ash	449
Net Revenue	414	State Environmental Regulation	45
Spark Spreads and Dark Spreads	415	State Coal Ash Regulations	45
Theoretical Energy Market Net Revenue	416	State Emissions Regulations	452
New Entrant Combustion Turbine	419	State Renewable Portfolio Standards	462
New Entrant Combined Cycle	420	Transco Regional Energy Access Expansion Project	483
New Entrant Coal Plant	421	Emission Controlled Capacity and Emissions	482
New Entrant Nuclear Plant	422	Emission Controlled Capacity	483
New Entrant Diesel	423	Emissions	484
New Entrant Onshore Wind Installation	424	Renewable Energy Output	487
New Entrant Offshore Wind Installation	424	Wind and Solar Peak Hour Output	487
New Entrant Solar Installation	425	Wind Units	488
Historical New Entrant CC Revenue Adequacy	425	Solar Units	490
Nuclear Net Revenue Analysis	426		

SECTION 9 Interchange Transactions	495	Interchange Transaction Issues	533
Overview	495	PJM Transmission Loading Relief Procedures (TLRs)	533
Interchange Transaction Activity	495	Up To Congestion Transactions	533
Interactions with Bordering Areas	495	Sham Scheduling	535
Recommendations	496	Elimination of Ontario Interface Pricing Point	536
Conclusion	497	PJM and NYISO Coordinated Interchange Transactions	537
Interchange Transaction Activity	498	Reserving Ramp on the PJM/NYISO Interface	541
Charges and Credits Applied to Interchange Transactions	498	PJM and MISO Coordinated Interchange Transaction Proposal	541
Aggregate Imports and Exports	499	Willing to Pay Congestion and Not Willing to Pay Congestion	544
Real-Time Interface Imports and Exports	501	Transmission Service Requests	545
Real-Time Interface Pricing Point Imports and Exports	502	Spot Imports	546
Day-Ahead Interface Imports and Exports	505	Interchange Optimization	547
Day-Ahead Interface Pricing Point Imports and Exports	507	Interchange Cap During Emergency Conditions	547
Loop Flows	511	45 Minute Schedule Duration Rule	548
PJM and MISO Interface Prices	517	MISO Multi-Value Project Usage Rate (MUR)	549
PJM and NYISO Interface Prices	519		
Summary of Interface Prices between PJM and Organized Markets	521	SECTION 10 Ancillary Service Markets	551
Neptune Underwater Transmission Line to Long Island, New York	521	Č	
Linden Variable Frequency Transformer (VFT) facility	523	Overview	552
Hudson Direct Current (DC) Merchant Transmission Line	525	Primary Reserve	552
Interchange Activity During High Load Hours	527	Synchronized Reserve Market	553
Operating Agreements with Bordering Areas	527	Nonsynchronized Reserve	554
PJM and MISO Joint Operating Agreement	528	30-Minute Reserve Market	555
PJM and New York Independent System Operator Joint		Regulation Market	555
Operating Agreement (JOA)	530	Black Start Service	557
PJM and TVA/LG&E and KU Joint Reliability Coordination		Reactive	557
Agreement (JRCA)	531	Frequency Response	557
PJM and Duke Energy Progress, Inc. Joint Operating Agreement	532	Market Procurement of Real-Time Ancillary Services	558
PJM and VACAR South Reliability Coordination Agreement	532	Recommendations	559
Balancing Authority Operations Coordination Agreement between		Conclusion	561
Wisconsin Electric Power Company (WEC) and PJM		PJM Reserve Markets	562
Interconnection, LLC	532	Implementation of PJM Reserve Markets	565
Northeastern ISO-Regional Transmission Organization Planning		Reserve Subzones	568
Coordination Protocol	532	Primary Reserve	570

vi Table of Contents © 2024 Monitoring Analytics, LLC

Market Structure	570	SECTION 11 Congestion and Marginal Losses	643
Market Performance	572	Overview	645
Synchronized Reserve	572	Congestion Cost	645
Market Structure	572	Marginal Loss Cost	646
Market Behavior	574	System Energy Cost	646
Market Performance	575	Conclusion	647
Synchronized Reserve Performance	579	lssues	647
Nonsynchronized Reserve	590	Artificial Constraints, Closed Loop Interfaces and CT Pricing Logic	
Market Structure	591	Locational Marginal Price (LMP)	648
Market Behavior	592	Components	648
Market Performance	592	Hub Components	653
30-Minute Reserve	596	Congestion	654
Market Structure	596	Congestion Congestion Accounting	654
Market Behavior	598	Total Congestion	657
Market Performance	598	Charges and Credits versus Congestion: Virtual Transactions,	057
Regulation Market	601	Load and Generation	658
Market Design	601	UTCs and Negative Balancing Explicit CLMP Charges	661
Market Structure	618	Zonal and Load Aggregate Congestion	664
Market Conduct	623	Fast Start Pricing Effect on Zonal Congestion	669
Market Performance	626	Monthly Congestion	670
Black Start Service	630	Congested Facilities	671
CRF Issues	633	<u> </u>	671
NERC - CIP	635	Congestion Event Hours	
Reactive Service and Capability	635	Congestion by Facility Type and Voltage	674 675
Issues with Reactive Capability Market Design	636	Constraint Frequency	
Reactive Costs	639	Top Constraints	677
Frequency Control Definition	641	Congestion Event Summary: Impact of Changes in UTC Volumes	683 683
Primary Frequency Response	641	Marginal Losses	
		Marginal Loss Accounting	683
		Total Marginal Loss Cost	685
		System Energy Costs	691
		Energy Accounting	691
		Total System Energy Costs	691

SECTION 12 Generation and Transmission Planning	697	SECTION 13 Financial Transmission and Auctio	n Revenue
Overview	697	Rights	789
Generation Interconnection Planning	697	Overview	79 3
Regional Transmission Expansion Plan (RTEP)	698	Auction Revenue Rights	79 3
Transmission Facility Outages	700	Financial Transmission Rights	794
Recommendations	700	Recommendations	796
Conclusion	702	Conclusion	797
Generation Interconnection Planning	707	Proposed Design	799
Existing Generation Mix	707	Auction Revenue Rights	800
Generation Retirements	714	Market Design	801
Generation Queue	719	Market Structure	802
Regional Transmission Expansion Plan (RTEP)	755	Market Performance	802
RTEP Process	755	1ARRs	809
Market Efficiency Process	755	Financial Transmission Rights	810
PJM MISO Interregional Market Efficiency Process (IMEP)	760	Market Performance	815
PJM MISO Targeted Market Efficiency Process (TMEP)	761	Surplus Congestion Revenue	836
Multi Driver Process	762	Revenue Adequacy	839
New Jersey State Agreement Approach for Offshore Wind	762	Target Allocations and Congestion by Constraint	843
Supplemental Transmission Projects	763	ARRs as an Offset to Congestion for Load	848
Competitive Planning Process Exclusions	767	Zonal ARR Congestion Offset	849
Storage As A Transmission Asset (SATA)	769	Offset if all ARRs are Held as ARRs	851
Board Authorized Transmission Upgrades	769	Offset if all ARRs are Self Scheduled	852
Qualifying Transmission Upgrades (QTU)	769	ARR Allocation and Congestion In and Out of Zone	853
Cost Allocation	770	Credit	853
Transmission Line Ratings	771	Default Portfolio Considerations	854
Dynamic Line Ratings (DLR) and Grid Enhancing Technology		FTR Forfeitures	854
(GETs)	773		
Transmission Facility Outages	774		
Scheduling Transmission Facility Outage Requests	774		
Rescheduling Transmission Facility Outage Requests	777		
Long Duration Transmission Facility Outage Requests	778		
Transmission Facility Outage Analysis for the FTR Market	779		
Transmission Facility Outage Analysis in the Day-Ahead Energy			
Market	786		

viii Table of Contents © 2024 Monitoring Analytics, LLC