Table of Contents		SECTION 2 Recommendations	53
		New Recommendations	53
		From Section 9, Interchange Transactions	53
Preface	i	From Section 10, Ancillary Services	54
		Complete List of MMU Recommendations	54
SECTION 1 Introduction	1	Section 3, Energy Market	54
03 2014 in Review	1	Section 4, Energy Uplift	55
PJM Market Summary Statistics	3	Section 5, Capacity	56
PJM Market Background	3	Section 6, Demand Response	57
Conclusions	5	Section 7, Net Revenue	58
Role of MMU	9	Section 8, Environmental	58
	9	Section 9, Interchange Transactions	58
Reporting Monitoring	9	Section 10, Ancillary Services	59
		Section 11, Congestion and Marginal Losses	59
Market Design New Recommendations	10	Section 12, Planning	59
	10	Section 13, FTRs and ARRs	60
From Section 9, Interchange Transactions	11		
From Section 10, Ancillary Services Total Price of Wholesale Power	11		
Components of Total Price	11 11	SECTION 3 Energy Market	61
Section Overviews	13	Overview	62
		Market Structure	62
Overview: Section 3, "Energy Market"	13	Market Behavior	63
Overview: Section 4, "Energy Uplift"	19	Market Performance	64
Overview: Section 5, "Capacity Market"	23	Scarcity	65
Overview: Section 6, "Demand Response"	26	Recommendations	65
Overview: Section 7, "Net Revenue"	29	Conclusion	66
Overview: Section 8, "Environmental and Renewables"	30	Market Structure	68
Overview: Section 9, "Interchange Transactions"	33	Market Concentration	68
Overview: Section 10, "Ancillary Services"	36	Ownership of Marginal Resources	70
Overview: Section 11, "Congestion and Marginal Losses"	41	Type of Marginal Resources	71
Overview: Section 12, "Planning"	43	Supply	72
Overview: Section 13, "FTR and ARRs"	45	Demand	81
		Supply and Demand: Load and Spot Market	90
		Market Behavior	92

Offer Capping for Local Market Power	92	Geography of Charges and Credits	157
Offer Capping for Local Market Power	93	Energy Uplift Issues	159
Markup	95	Lost Opportunity Cost Credits	159
Frequently Mitigated Units and Associated Units	96	Black Start Service Units	161
Virtual Offers and Bids	99	Reactive / Voltage Support Units	162
Generator Offers	111	Confidentiality of Energy Uplift Information	164
Market Performance	112	Energy Uplift Recommendations	164
Markup	112	Credits Recommendations	164
Prices	119	Allocation Recommendations	168
Scarcity	135	Quantifiable Recommendations Impact	171
Emergency procedures	135	July through September 2014 Energy Uplift Charges Decrease	172
SECTION 4 Energy Uplift (Operating Reserves)	139	SECTION 5 Capacity Market	175
Overview	139	Overview	175
Energy Uplift Results	139	RPM Capacity Market	175
Characteristics of Credits	139	Generator Performance	177
Geography of Charges and Credits	139	Recommendations	177
Energy Uplift Issues	140	Conclusion	178
Energy Uplift Recommendations	140	Installed Capacity	181
Recommendations	140	RPM Capacity Market	181
Conclusion	141	Market Structure	181
Energy Uplift	142	Market Conduct	188
Credits and Charges Categories	142	Market Performance	188
Energy Uplift Results	144	Generator Performance	193
Energy Uplift Charges	144	Capacity Factor	193
Operating Reserve Rates	147	Generator Performance Factors	194
Reactive Services Rates	150	Generator Forced Outage Rates	196
Balancing Operating Reserve Determinants	151		
Energy Uplift Credits	152		
Characteristics of Credits	153	SECTION 6 Demand Response	207
Types of Units	153	Overview	207
Concentration of Energy Uplift Credits	153	Recommendations	208
Economic and Noneconomic Generation	155	Conclusion	209

iv Table of Contents © 2014 Monitoring Analytics, LLC

PJM Demand Response Programs	210	Emission Standards for Reciprocating Internal Combustion	
Participation in Demand Response Programs	210	Engines	249
Economic Program	211	Regulation of Greenhouse Gas Emissions	251
Emergency Program	219	Federal Regulation of Environmental Impacts on Water	252
		State Environmental Regulation	253
		New Jersey High Electric Demand Day (HEDD) Rules	253
SECTION 7 Net Revenue	237	Illinois Air Quality Standards ( $NO_x$ , $SO_2$ and $Hg$ )	253
Overview	237	State Regulation of Greenhouse Gas Emissions	253
Net Revenue	237	Renewable Portfolio Standards	255
Conclusion	237	Emissions Controlled Capacity and Renewables in PJM Markets	260
Net Revenue	238	Emission Controlled Capacity in the PJM Region	260
Theoretical Energy Market Net Revenue	239	Wind Units	261
New Entrant Combustion Turbine	241	Solar Units	263
New Entrant Combined Cycle	242		
New Entrant Coal Plant	242	CECTION O Interchange Transportions	265
New Entrant Diesel	243	SECTION 9 Interchange Transactions	265
New Entrant Nuclear Plant	243	0verview	265
New Entrant Wind Installation	244	Interchange Transaction Activity	265
New Entrant Solar Installation	244	Interactions with Bordering Areas	265
		Recommendations	267
CECTION OF ' (1 ID II E		Conclusion	267
SECTION 8 Environmental and Renewable Energy		Interchange Transaction Activity	268
Regulations	245	Aggregate Imports and Exports	268
Overview	245	Real-Time Interface Imports and Exports	269
Federal Environmental Regulation	245	Real-Time Interface Pricing Point Imports and Exports	271
State Environmental Regulation	246	Day-Ahead Interface Imports and Exports	274
Emissions Controls in PJM Markets	247	Day-Ahead Interface Pricing Point Imports and Exports	277
State Renewable Portfolio Standards	247	Loop Flows	284
Conclusion	247	PJM and MISO Interface Prices	288
Federal Environmental Regulation	248	PJM and NYISO Interface Prices	291
Control of Mercury and Other Hazardous Air Pollutants	248	Summary of Interface Prices between PJM and Organized Markets	
Air Quality Standards: Control of NO <sub>x</sub> , SO <sub>2</sub> and O <sub>3</sub> Emissions		Neptune Underwater Transmission Line to Long Island, New York	
Allowances	248	Linden Variable Frequency Transformer (VFT) facility	294
		Hudson Direct Current (DC) Merchant Transmission Line	294

Operating Agreements with Bordering Areas	295	Ancillary Services Costs per MWh of Load: January through	
PJM and MISO Joint Operating Agreement	295	June, 2003 through 2014	318
PJM and New York Independent System Operator Joint		Recommendations	319
Operating Agreement (JOA)	296	Conclusion	319
PJM, MISO and TVA Joint Reliability Coordination		Primary Reserve	320
Agreement (JRCA)	298	Market Structure	320
PJM and Progress Energy Carolinas, Inc. Joint Operating		Price and Cost	323
Agreement	299	Tier 1 Synchronized Reserve	324
PJM and VACAR South Reliability Coordination Agreement	299	Market Structure	325
Interface Pricing Agreements with Individual Balancing Authorities	s 299	Tier 2 Synchronized Reserve Market	332
Other Agreements with Bordering Areas	300	Market Structure	332
Interchange Transaction Issues	301	Market Behavior	337
PJM Transmission Loading Relief Procedures (TLRs)	301	Market Performance	338
Up-To Congestion	302	Non-Synchronized Reserve Market	344
Sham Scheduling	305	Market Structure	344
Elimination of Ontario Interface Pricing Point	305	Secondary Reserve (DASR)	347
PJM and NYISO Coordinated Interchange Transaction Proposal	306	Market Structure	347
PJM and MISO Coordinated Interchange Transaction Proposal	307	Market Conduct	348
Willing to Pay Congestion and Not Willing to Pay Congestion	309	Market Performance	348
Spot Imports	309	Regulation Market	350
Interchange Optimization	310	Market Design	350
45 Minute Schedule Duration Rule	310	Market Structure	352
		Market Conduct	358
		Market Performance	361
SECTION 10 Ancillary Service Markets	313	Black Start Service	363
Overview	314	Reactive Service	365
Primary Reserve	314		
Tier 1 Synchronized Reserve	314	CDOTION 44 O C LINE 1 1	265
Tier 2 Synchronized Reserve Market	315	SECTION 11 Congestion and Marginal Losses	367
Non-Synchronized Reserve Market	316	Overview	367
Secondary Reserve	316	Congestion Cost	367
Regulation Market	317	Marginal Loss Cost	368
Black Start Service	318	Energy Cost	369
Reactive	318	Conclusion	369

vi Table of Contents © 2014 Monitoring Analytics, LLC

Locational Marginal Price (LMP)	369	Planned Generation Additions	397
Components	369	Planned Retirements	400
Zonal Components	370	Generation Mix	404
Hub Components	371	Generation and Transmission Interconnection Planning Process	405
Component Costs	372	Small Generator Interconnection	405
Congestion	373	Interconnection Study Phase	407
Congestion Accounting	373	Regional Transmission Expansion Plan (RTEP)	408
Total Congestion	373	Artificial Island	408
Congested Facilities	375	Other RTEP Proposals	408
Congestion by Facility Type and Voltage	375	Backbone Facilities	409
Constraint Duration	379		
Constraint Costs	381	CDOMONIA O EL CLATA COMO COMO COMO COMO COMO COMO COMO COM	
Congestion-Event Summary for MISO Flowgates	384	SECTION 13 Financial Transmission and Auction	
Congestion-Event Summary for NYISO Flowgates	385	Revenue Rights	411
Congestion-Event Summary for the 500 kV System	386	Overview	41
Congestion Costs by Physical and Financial Participants	387	Financial Transmission Rights	41
Congestion-Event Summary before and after September 8th, 201	4 388	Auction Revenue Rights	413
Marginal Losses	388	Recommendations	414
Marginal Loss Accounting	388	Conclusion	414
Total Marginal Loss Costs	389	Financial Transmission Rights	417
Energy Costs	391	Market Structure	418
Energy Accounting	391	Market Behavior	420
Total Energy Costs	391	Market Performance	422
		Revenue Adequacy Issues and Solutions	433
CDCDION 10 O C III II II II II	205	Auction Revenue Rights	438
SECTION 12 Generation and Transmission Planning	395	Market Structure	439
Overview	395	Market Performance	443
Planned Generation and Retirements	395		
Generation and Transmission Interconnection Planning Process	395		
Regional Transmission Expansion Plan (RTEP)	395		
Backbone Facilities	396		
Recommendations	396		
Conclusion	396		
Planned Generation and Retirements	397		

viii Table of Contents © 2014 Monitoring Analytics, LLC

Figures		Figure 3-13 PJM footprint calendar year peak loads: January through September of 1999 to 2014	0′
		Figure 3-14 PJM peak-load comparison: Tuesday, June 17, 2014, and	82
		Tuesday, July 18, 2013	83
SECTION 1 Introduction	1	Figure 3-15 Distribution of PJM real-time accounting load plus expor	
Figure 1-1 PJM's footprint and its 20 control zones	4	January through September of 2013 and 2014	84
Figure 1-2 PJM reported monthly billings (\$ Billions): January 2008		Figure 3-16 PJM real-time monthly average hourly load: January 201	
through September 2014	4	through September 2014	85
		Figure 3-17 PJM heating and cooling degree days: January 2013	
		through September 2014	85
SECTION 3 Energy Market	61	Figure 3-18 Distribution of PJM day-ahead demand plus exports:	
Figure 3-1 Fuel source distribution in unit segments: January through		January through September of 2013 and 2014	87
September, 2014	69	Figure 3-19 PJM day-ahead monthly average hourly demand: January	/
Figure 3-2 PJM hourly Energy Market HHI: January through		2013 through September 2014	88
September, 2014	70	Figure 3-20 Day-ahead and real-time demand (Average hourly	
Figure 3-3 Day-ahead marginal up-to congestion transaction and		volumes): January through September of 2014	90
generation units: January through September 2014	72	Figure 3-21 Difference between day-ahead and real-time demand	
Figure 3-4 Day-ahead marginal up-to congestion transaction and		(Average daily volumes): January 2013 through September 2014	90
generation units: August 18, 2014, through September 30, 2014	72	Figure 3-22 Frequently mitigated units and associated units total	
Figure 3-5 Average PJM aggregate real-time generation supply curves:		months eligible: February, 2006 through September, 2014	97
January through September of 2013 and 2014	73	Figure 3-23 Frequently mitigated units and associated units (By	
Figure 3-6 Distribution of PJM real-time generation plus imports:		month): February, 2006 through September, 2014	98
January through September of 2013 and 2014	75	Figure 3-24 PJM day-ahead aggregate supply curves: 2014 example	
Figure 3-7 PJM real-time average monthly hourly generation: January		day	100
2013 through September 2014	76	Figure 3-25 Monthly bid and cleared INCs, DECs, and UTCs (MW):	
Figure 3-8 Distribution of PJM day-ahead supply plus imports:		January 2005 through September 2014	102
January through September of 2013 and 2014	77	Figure 3-26 Daily bid and cleared INCs, DECs, and UTCs (MW):	100
Figure 3-9 PJM day-ahead monthly average hourly supply:	70	January 2013 through September 2014	103
January 2013 through September 2014	78	Figure 3-27 Daily bid and cleared INCs, DECs, and UTCs (MW):	100
Figure 3-10 Day-ahead and real-time supply (Average hourly	00	July 2014 through September 2014  Figure 2, 28 PIM elegand up to congestion transactions by type (MM)	103
volumes): January through September of 2014 Figure 3-11 Difference between day-ahead and real-time supply	80	Figure 3-28 PJM cleared up-to congestion transactions by type (MW): January 2005 through September 2014	110
(Average daily volumes): January 2013 through September of 2014	80	Figure 3-29 PJM daily cleared up-to congestion transaction by type	110
Figure 3-12 Map of PJM real-time generation less real-time load by	00	(MW): January 2013 through September 2014	110
zone: January through Sentember of 2014	81	(iiii) validary 2013 tillough September 2011	

Figure 3-30 PJM daily cleared up-to congestion transaction by type		Figure 4-3 Daily balancing operating reserve deviation rates	
(MW): July through September 2014	111	(\$/MWh): 2013 and 2014	149
Figure 3-31 Average LMP for the PJM Real-Time Energy Market:		Figure 4-4 Daily lost opportunity cost and canceled resources rates	
January through September of 2013 and 2014	120	(\$/MWh): 2013 and 2014	149
Figure 3-32 PJM real-time, load-weighted, average LMP: January		Figure 4-5 Daily reactive transfer interface support rates (\$/MWh):	
through September 2013	122	2013 and 2014	151
Figure 3-33 PJM real-time, load-weighted, average LMP: January		Figure 4-6 PJM Closed Loop Interfaces Map	163
through September 2014	122	Figure 4-7 Energy uplift charges change from July through	
Figure 3-34 PJM real-time, load-weighted, average LMP: July		September 2013 to July through September 2014 by category	172
through September 2013	123		
Figure 3-35 PJM real-time, load-weighted, average LMP: July		CDOTION - O	
through September 2014	123	SECTION 5 Capacity Market	175
Figure 3-36 PJM real-time, monthly and annual, load-weighted,		Figure 5-1 Map of PJM Locational Deliverability Areas	184
average LMP: 1999 through September of 2014	123	Figure 5-2 Map of PJM RPM EMAAC subzonal LDAs	184
Figure 3-37 Spot average fuel price comparison with fuel delivery		Figure 5-3 Map of PJM RPM ATSI subzonal LDA	184
charges: 2012 through 2014 (\$/MMBtu)	124	Figure 5-4 History of PJM capacity prices: 1999/2000 through	
Figure 3-38 Average LMP for the PJM Day-Ahead Energy Market:		2017/2018	191
January through September of 2013 and 2014	127	Figure 5-5 Map of RPM capacity prices: 2014/2015 through	
Figure 3-39 Day-ahead, monthly and annual, load-weighted, average		2017/2018	192
LMP: 2000 through September of 2014	128	Figure 5-6 PJM outages (MW): January 2012 through September 2014	194
Figure 3-40 Real-time hourly LMP minus day-ahead hourly LMP:		Figure 5-7 PJM equivalent outage and availability factors: January	
January through September of 2014	134	through September, 2007 to 2014	195
Figure 3-41 Monthly average of real-time minus day-ahead LMP:		Figure 5-8 Trends in the PJM equivalent demand forced outage rate	
January through September of 2014	134	(EFORd): January through September, 2007 through 2014	196
Figure 3-42 PJM system hourly average LMP: January through		Figure 5-9 PJM distribution of EFORd data by unit type: January	
September of 2014	135	through September 2014	197
		Figure 5-10 PJM EFORd, XEFORd and EFORp: January through	
SECTION 4 Energy Uplift (Operating Reserves)	139	September 2014	204
	133	Figure 5-11 PJM monthly generator performance factors: January	
Figure 4-1 Daily day-ahead operating reserve rate (\$/MWh): 2013	1.10	through September 2014	205
and 2014	148		
Figure 4-2 Daily balancing operating reserve reliability rates	1.40		
(\$/MWh): 2013 and 2014	148		

x Table of Contents © 2014 Monitoring Analytics, LLC

SECTION 6 Demand Response	207	Figure 9-2 PJM real-time and day-ahead scheduled import and expo	rt
Figure 6-1 Demand response revenue by market: January through September, 2008 through 2014	211	transaction volume history: 1999 through September, 2014 Figure 9-3 PJM's footprint and its external interfaces Figure 9-4 Pool time and day should drill hourshy average price	269 283
Figure 6-2 Economic program credits and MWh by month: January, 2010 through September, 2014	214	Figure 9-4 Real-time and day-ahead daily hourly average price difference (MISO Interface minus PJM/MISO): January through September, 2014	290
Figure 6-3 Distribution of participant event days across ranges of performance levels across the events: January through September, 2014	231	Figure 9-5 Real-time and day-ahead daily hourly average price difference (NY proxy - PJM/NYIS): January through	
		September, 2014 Figure 9-6 PJM, NYISO and MISO real-time and day-ahead border	292
SECTION 7 Net Revenue	237	price averages: January through September, 2014	293
Figure 7-1 Energy Market net revenue factor trends: 2009 through September 2014	239	Figure 9-7 Neptune hourly average flow: January through September, 2014	294
Figure 7-2 Average zonal operating costs: 2009 through September	0.44	Figure 9-8 Linden hourly average flow: January through September, 2014	294
2014	241	Figure 9-9 Hudson hourly average flow: January through September, 2014	295
SECTION 8 Environmental and Renewable Energy		Figure 9-10 Credits for coordinated congestion management:	
Regulations	245	January through September, 2014 Figure 9-11 Credits for coordinated congestion management	296
Figure 8-1 Spot monthly average emission price comparison: 2013 and January through September of 2014	255	(flowgates): January through September, 2014 Figure 9-12 Credits for coordinated congestion management	297
Figure 8-2 Average hourly real-time generation of wind units in PJM: January through September, 2014	261	(Ramapo PARs): January through September, 2014 Figure 9-13 Monthly up-to congestion cleared bids in MWh:	298
Figure 8-3 Average hourly day-ahead generation of wind units in		January, 2005 through September, 2014	303
PJM: January through September, 2014 Figure 8-4 Marginal fuel at time of wind generation in PJM: January	262	Figure 9-14 Spot import service utilization: January, 2009 through	216
through September, 2014	263	September, 2014	310
Figure 8-5 Average hourly real-time generation of solar units in PJM January through September, 2014	l: 263	SECTION 10 Ancillary Service Markets	313
SECTION 9 Interchange Transactions	265	Figure 10-1 PJM RTO geography and primary reserve requirement: January through September 2014	321
Figure 9-1 PJM real-time and day-ahead scheduled imports and exports: January through September, 2014	269	Figure 10-2 Mid-Atlantic Dominion subzone primary reserve MW by source (Daily Averages): January through September 2014	322

Figure 10-3 RTO subzone primary reserve MW by source (Daily		Figure 10-17 Daily average components of DASR clearing price,	
Averages): January through September 2014	323	marginal unit offer and LOC: January through September 2014	349
Figure 10-4 Daily average market clearing prices for synchronized		Figure 10-18 Daily average DASR prices and MW by classification:	
reserve and non-synchronized reserve: January through		January through September, 2014	349
September 2014	324	Figure 10-19 Hourly average performance score by unit type and	
Figure 10-5 Daily average tier 1 synchronized reserve supply in the		regulation signal type: January through September 2014	351
MAD subzone: January through September, 2014	326	Figure 10-20 Daily average marginal benefit factor and mileage ratio:	
Figure 10-6 Absolute value of the tier 1 estimate minus the actual		January through September 2014	352
value by market hour, January through September 2014	330	Figure 10-21 All (RegA and RegD) cleared regulation: Daily average	
Figure 10-7 Cleared Tier 2 Synchronized Reserve by Unit Type, Full		actual cleared MW of regulation, effective cleared MW of	
RTO Zone, January through September, 2014	333	regulation, and average performance score: January through	
Figure 10-8 Monthly average actual vs default synchronized reserve		September 2014	354
requirements, RTO and MAD: January through September, 2014	334	Figure 10-22 Only RegD cleared regulation: Daily average actual	
Figure 10-9 Mid-Atlantic Dominion Reserve subzone monthly average		cleared MW of regulation, effective cleared MW of regulation,	
synchronized reserve required vs. tier 2 synchronized reserve		and average performance score; RegD units: January through	
scheduled MW: January through September 2014	335	September 2014	355
Figure 10-10 RTO Reserve zone monthly average synchronized		Figure 10-23 PJM monthly CPS1 and BAAL performance:	
reserve required vs. tier 2 synchronized reserve scheduled MW:		January 2011 through September 2014	356
January through September 2014	336	Figure 10-24 PJM Regulation Market HHI distribution: January	
Figure 10-11 Tier 2 synchronized reserve daily average offer and		through September 2013 and 2014	357
eligible volume (MW): January through September 2014	337	Figure 10-25 Off peak and on peak regulation levels: January	
Figure 10-12 Mid-Atlantic Dominion subzone average daily tier 2		through September 2014	359
synchronized reserve offer by unit type (MW): January through		Figure 10-26 PJM Regulation Market daily weighted average	
September 2012 through 2014	338	market-clearing price, marginal unit opportunity cost and offer	
Figure 10-13 RTO Zone average daily tier 2 synchronized reserve		price (Dollars per MW): 2014	361
offer by unit type (MW): January through September 2012		Figure 10-27 Comparison of monthly average RegA and RegD RMCP	
through 2014	338	Credits per Effective MW: October 2012 through September 2014	363
Figure 10-14 Spinning events duration distribution curve, January			
through September 2011 through 2014	344		
Figure 10-15 Daily average MAD subzone Non-Synchronized Reserve		SECTION 11 Congestion and Marginal Losses	367
Market clearing price and MW purchased: January through		Figure 11-1 PJM monthly total congestion cost (Dollars (Millions)):	
September 2014	346	2009 through September of 2014	375
Figure 10-16 Daily average RTO Zone Non-Synchronized Reserve		Figure 11-2 Location of the top 10 constraints affecting PJM	
Market clearing price and MW purchased: January through		congestion costs: January through September of 2014	383
September 2014	346		

xii Table of Contents © 2014 Monitoring Analytics, LLC

Figure 11-3 Daily congestion event hours: January through	200	Figure 13-8 FTR payout ratio by month, excluding and including
September 2014 Figure 11-4 PJM monthly marginal loss costs (Dollars (Millions)):	388	excess revenue distribution: January 2004 through September 2014
January 2009 through September 2014	390	Figure 13-9 FTR surplus and the collected Day-Ahead, Balancing and
Figure 11-5 PJM monthly energy costs (Dollars (Millions)):	330	Total congestion: January 2005 through September 2014
January 2009 through September 2014	393	Figure 13-10 FTR target allocation compared to sources of positive
January 2005 through September 2014	333	and negative congestion revenue
		Figure 13-11 Historic Stage 1B and Stage 2 ARR Allocations from the
SECTION 12 Generation and Transmission Planning	395	2011 to 2012 through 2014 to 2015 planning periods
Figure 12-1 Map of PJM unit retirements: 2011 through 2019	401	Figure 13-12 Annual FTR Auction prices vs. average day-ahead and
Figure 12-2 PJM capacity (MW) by age (years): at September 30, 201	4 405	real-time congestion for all control zones relative to the Western
Figure 12-3 PJM Backbone Projects	410	Hub: 2014 to 2015 planning period
SECTION 13 Financial Transmission and Auction		
	411	
Revenue Rights	411	
Figure 13-1 Illustration of INC/DEC FTR forfeiture rule	420	
Figure 13-2 Monthly FTR forfeitures for physical and financial		
participants: June 2010 through September 2014	421	
Figure 13-3 FTR forfeitures for INCs/DECs and INCs/DECs/UTCs for		
both the PJM and MMU methods: January 2013 through		
September 2014	421	
Figure 13-4 Cleared auction volume (MW) as a percent of total		
FTR cleared volume by calendar month: June 2004 through		
September 2014	424	
Figure 13-5 Long Term, Annual and Monthly FTR Auction bid and	405	
cleared volume: June 2003 through September 2014	425	
Figure 13-6 Ten largest positive and negative FTR target allocations		
summed by sink: 2014 to 2015 planning period through September	427	
Figure 13-7 Ten largest positive and negative FTR target allocations	441	
summed by source: 2014 to 2015 planning period through		
September	428	
September 1	.20	

xiv Table of Contents © 2014 Monitoring Analytics, LLC

## Tables

Tables		September of 2013 and 2014	73
		Table 3-9 Monthly PJM generation (By fuel source (GWh)): January	
SECTION 1 Introduction	1	through September of 2014	74
Table 1-1 PJM Market Summary Statistics, January through September		Table 3-10 PJM real-time average hourly generation and real-time average hourly generation plus average hourly imports: January	
2013 and 2014	,	through September of 2000 through 2014	76
Table 1-2 The Energy Market results were competitive	6	Table 3-11 PJM day-ahead average hourly supply and day-ahead	70
Table 1-3 The Capacity Market results were competitive	7	average hourly supply plus average hourly imports: January	
Table 1-4 The Regulation Market results were competitive	7	through September of 2000 through 2014	78
Table 1-5 The Synchronized Reserve Markets results were competitive	8	Table 3-12 Day-ahead and real-time supply (MWh): January through	
Table 1-6 The Day-Ahead Scheduling Reserve Market results were		September of 2013 and 2014	79
competitive	8	Table 3-13 PJM real-time generation less real-time load by zone	
Table 1-7 The FTR Auction Markets results were competitive	8	(GWh): January through September of 2013 and 2014	81
Table 1-8 Total price per MWh by category: January through		Table 3-14 Actual PJM footprint peak loads: January through	
September, 2013 and 2014	13	September of 1999 to 2014	82
		Table 3-15 PJM real-time average hourly load and real-time average	
CECTION OF MILE	<b>.</b>	hourly load plus average hourly exports: January through	
SECTION 3 Energy Market	61	September of 1998 through 2014	84
Table 3-1 The Energy Market results were competitive	61	Table 3-16 PJM heating and cooling degree days: January 2013	
Table 3-2 PJM hourly Energy Market HHI: January through		through September 2014	86
September, 2013 and 2014	69	Table 3-17 PJM day-ahead average demand and day-ahead average	
Table 3-3 PJM hourly Energy Market HHI (By supply segment):		hourly demand plus average hourly exports: January through	
2013 and 2014	69	September of 2000 through 2014	87
Table 3-4 Marginal unit contribution to PJM real-time, load-weighted		Table 3-18 Cleared day-ahead and real-time demand (MWh): January	
LMP (By parent company): January through September 2013 and		through September of 2013 and 2014	89
2014	70	Table 3-19 Monthly average percentage of real-time self-supply load,	
Table 3-5 Marginal resource contribution to PJM day-ahead,		bilateral-supply load and spot-supply load based on parent	
load-weighted LMP (By parent company): January through		companies: 2013 through 2014	91
September 2013 and 2014	70	Table 3-20 Monthly average percentage of day-ahead self-supply	
Table 3-6 Type of fuel used (By real-time marginal units): January		demand, bilateral supply demand, and spot-supply demand based	
through September 2013 and 2014	71	on parent companies: 2013 through 2014	92
Table 3-7 Day-ahead marginal resources by type/fuel: January		Table 3-21 Offer-capping statistics – Energy only: January through	
through September 2013 and 2014	71	September, 2010 to 2014	92

Table 3-8 PJM generation (By fuel source (GWh)): January through

Table 3-22 Offer-capping statistics for energy and reliability: January		Table 3-39 PJM virtual offers and bids by top ten locations (MW):	
through September, 2010 to 2014	93	January through September of 2013 and 2014	105
Table 3-23 Real-time offer-capped unit statistics: January through		Table 3-40 PJM cleared up-to congestion import bids by top ten	
September, 2013 and 2014	93	source and sink pairs (MW): January through September of 2013	
Table 3-24 Numbers of hours when control zones experienced		and 2014	106
congestion for 50 or more hours: January through September,		Table 3-41 PJM cleared up-to congestion export bids by top ten	
2009 through 2014	93	source and sink pairs (MW): January through September of	
Table 3-25 Three pivotal supplier test details for interface constraints:		2013 and 2014	106
January through September, 2014	94	Table 3-42 PJM cleared up-to congestion wheel bids by top ten	
Table 3-26 Summary of three pivotal supplier tests applied for		source and sink pairs (MW): January through September of	
interface constraints: January through September, 2014	95	2013 and 2014	107
Table 3-27 Average, real-time marginal unit markup index (By offer		Table 3-43 PJM cleared up-to congestion internal bids by top ten	
price category): January through September 2013 and 2014	95	source and sink pairs (MW): January through September of	
Table 3-28 Average day-ahead marginal unit markup index (By offer		2013 and 2014	107
price category): January through September of 2013 and 2014	96	Table 3-44 Number of PJM offered and cleared source and sink	
Table 3-29 Frequently mitigated units and associated units total		pairs: January 2012 through September 2014	108
months eligible: 2013 and January through September, 2014	97	Table 3-45 PJM cleared up-to congestion transactions by type (MW):	
Table 3-30 Number of frequently mitigated units and associated units		January through September of 2013 and 2014	109
(By month): 2013 and January through September, 2014	98	Table 3-46 Distribution of MW for dispatchable unit offer prices:	
Table 3-31 Frequently mitigated units at risk of retirement: 2013	99	January through September of 2014	111
Table 3-32 Hourly average number of cleared and submitted INCs,		Table 3-47 Distribution of MW for self scheduled offer prices:	
DECs by month: January 2013 through September of 2014	100	January through September of 2014	112
Table 3-33 Hourly average of cleared and submitted up-to congestion		Table 3-48 Markup component of the overall PJM real-time, load-	
bids by month: January 2013 through September of 2014	101	weighted, average LMP by primary fuel type and unit type:	
Table 3-34 Hourly average number of cleared and submitted import		January through September 2013 and 2014	114
and export transactions by month: January 2013 through		Table 3-49 Monthly markup components of real-time load-weighted	
September of 2014	101	LMP (Unadjusted): January through September 2013 and 2014	114
Table 3-35 Type of day-ahead marginal units: January through		Table 3-50 Monthly markup components of real-time load-weighted	
September of 2014	102	LMP (Adjusted): January through September 2013 and 2014	114
Table 3-36 PJM INC and DEC bids by type of parent organization		Table 3-51 Average real-time zonal markup component (Unadjusted):	
(MW): January through September of 2013 and 2014	104	January through September, 2013 and 2014	115
Table 3-37 PJM up-to congestion transactions by type of parent		Table 3-52 Average real-time zonal markup component (Adjusted):	
organization (MW): January through September of 2013 and 2014	104	January through September, 2013 and 2014	115
Table 3-38 PJM import and export transactions by type of parent		Table 3-53 Average real-time markup component (By price category,	
organization (MW): January through September of 2013 and 2014	104	unadjusted): January through September 2013 and 2014	116

xvi Table of Contents © 2014 Monitoring Analytics, LLC

Table 3-54 Average real-time markup component (By price category,		Table 3-68 Components of PJM real-time (Unadjusted), annual,	
adjusted): January through September, 2013 and 2014	116	load-weighted, average LMP: January through September, 2013	
Table 3-55 Markup component of the annual PJM day-ahead, load-		and 2014	126
weighted, average LMP by primary fuel type and unit type:		Table 3-69 Components of PJM real-time (Adjusted), annual,	
January through September of 2013 and 2014	116	load-weighted, average LMP: January through September,	
Table 3-56 Monthly markup components of day-ahead (Unadjusted),		2013 and 2014	126
load-weighted LMP: January through September of 2013		Table 3-70 PJM day-ahead, average LMP (Dollars per MWh): January	
and 2014	117	through September of 2001 through 2014	127
Table 3-57 Monthly markup components of day-ahead (Adjusted),		Table 3-71 PJM day-ahead, load-weighted, average LMP (Dollars per	
load-weighted LMP: January through September of 2013		MWh): January through September of 2001 through 2014	128
and 2014 117		Table 3-72 Components of PJM day-ahead, (unadjusted) annual,	
Table 3-58 Day-ahead, average, zonal markup component		load-weighted, average LMP (Dollars per MWh): January through	
(Unadjusted): January through September of 2013 and 2014	118	September of 2013 and 2014	129
Table 3-59 Day-ahead, average, zonal markup component (Adjusted):		Table 3-73 Components of PJM day-ahead, (adjusted) annual,	
January through September of 2013 and 2014	118	load-weighted, average LMP (Dollars per MWh): January through	
Table 3-60 Average, day-ahead markup (By LMP category,		September of 2013 and 2014	130
unadjusted): January through September of 2013 and 2014	119	Table 3-74 Cleared UTC profitability by source and sink point:	
Table 3-61 Average, day-ahead markup (By LMP category, adjusted):		January through September of 2013 and 2014	131
January through June of 2013 and 2014	119	Table 3-75 Day-ahead and real-time average LMP (Dollars per MWh):	
Table 3-62 PJM real-time, average LMP (Dollars per MWh): January		January through September of 2013 and 2014	132
through September of 1998 through 2014	120	Table 3-76 Day-ahead and real-time average LMP (Dollars per MWh):	
Table 3-63 PJM real-time, load-weighted, average LMP (Dollars per		January through September of 2001 through 2014	132
MWh): January through September of 1998 through 2014	121	Table 3-77 Frequency distribution by hours of PJM real-time LMP	
Table 3-64 Zone real-time and real-time, load-weighted, average		minus day-ahead LMP (Dollars per MWh): January through	
LMP (Dollars per MWh): January through September 2013 and		September of 2007 through 2014	133
2014	121	Table 3-78 Summary of emergency events declared January through	
Table 3-65 Zone real-time and real-time, load-weighted, average LMP		September, 2013 and 2014	135
(Dollars per MWh): July through September 2013 and 2014	122	Table 3-79 Description of Emergency Procedures	137
Table 3-66 PJM real-time annual, fuel-cost adjusted, load-weighted		Table 3-80 PJM declared emergency alerts, warnings and actions:	
average LMP (Dollars per MWh): nine months over nine months	124	January through September, 2014	138
Table 3-67 Change in PJM real-time annual, fuel-cost adjusted,			
load-weighted average LMP (Dollars per MWh) by Fuel-type:	105		
nine months over nine months	125		

SECTION 4 Energy Uplift (Operating Reserves)	139	Table 4-18 Energy uplift credits by unit type: January through	
Table 4-1 Day-ahead and balancing operating reserve credits and		September 2013 and 2014	153
charges	143	Table 4–19 Energy uplift credits by unit type: January through	150
Table 4-2 Reactive services, synchronous condensing and black start		September 2014  Table 4.20 Ton 10 communifity and its units (D) approach of total	153
services credits and charges	143	Table 4-20 Top 10 energy uplift credits units (By percent of total system): January through September 2013 and 2014	154
Table 4-3 Total energy uplift charges: January through September		Table 4–21 Top 10 units and organizations energy uplift credits:	134
2013 and 2014	144	January through September 2014	154
Table 4-4 Energy uplift charges by category: January through		Table 4–22 Identification of balancing operating reserve credits	154
September 2013 and 2014	144	received by the top 10 units by category and region: January	
Table 4-5 Monthly energy uplift charges: 2013 and 2014	145	through September 2014	154
Table 4-6 Day-ahead operating reserve charges: January through		Table 4-23 Daily energy uplift credits HHI: January through	דכו
September 2013 and 2014	145	September 2014	155
Table 4-7 Balancing operating reserve charges: January through		Table 4-24 Day-ahead and real-time generation (GWh): January	
September 2013 and 2014	146	through September 2014	155
Table 4-8 Balancing operating reserve deviation charges: January		Table 4-25 Day-ahead and real-time economic and noneconomic	
through September 2013 and 2014	146	generation from units eligible for operating reserve credits	
Table 4-9 Additional energy uplift charges: January through	1.46	(GWh): January through September 2014	156
September 2013 and 2014	146	Table 4-26 Day-ahead and real-time generation receiving operating	
Table 4-10 Regional balancing charges allocation: January through September 2013	147	reserve credits (GWh): January through September 2014	156
Table 4-11 Regional balancing charges allocation: January through	147	Table 4-27 Day-ahead generation scheduled as must run by PJM	
September 2014	147	(GWh): 2013 and 2014	156
Table 4-12 Operating reserve rates (\$/MWh): January through	147	Table 4-28 Day-ahead generation scheduled as must run by PJM by	
September 2013 and 2014	149	category (GWh): 2014	157
Table 4-13 Operating reserve rates statistics (\$/MWh): January	113	Table 4-29 Geography of regional charges and credits: January	
through September 2014	150	through September 2014	158
Table 4-14 Local voltage support rates: January through September		Table 4-30 Geography of reactive services charges: January through	
2013 and 2014	150	September 2014	159
Table 4-15 Balancing operating reserve determinants (MWh): January		Table 4-31 Monthly lost opportunity cost credits: 2013 and 2014	159
through September 2013 and 2014	151	Table 4-32 Day-ahead generation from combustion turbines and	
Table 4-16 Deviations by transaction type: January through		diesels (GWh): 2013 and 2014	160
September 2014	151	Table 4-33 Lost opportunity cost credits paid to combustion turbines	1.61
Table 4-17 Energy uplift credits by category: January through		and diesels by scenario: 2013 and 2014	161
September 2013 and 2014	152		

xviii Table of Contents © 2014 Monitoring Analytics, LLC

Table 4–34 Day-ahead generation (GWh) from combustion turbines and diesels receiving lost opportunity cost credits by value: 2013		Table 5-14 RPM cost to load: 2013/2014 through 2017/2018 RPM Auctions	193
and 2014	161	Table 5-15 PJM capacity factor (By unit type (GWh)): January	
Table 4-35 PJM Closed Loop Interfaces	162	through September of 2013 and 2014	194
Table 4-36 Impact on energy market lost opportunity cost credits of		Table 5-16 EAF by unit type: January through September, 2007	
rule changes: January through September 2014	168	through 2014	195
Table 4-37 Current energy uplift allocation	170	Table 5-17 EMOF by unit type: January through September, 2007	
Table 4-38 MMU energy uplift allocation proposal	171	through 2014	195
Table 4-39 Current and proposed average energy uplift rate by		Table 5-18 EPOF by unit type: January through September, 2007	
transaction: 2013 and January through September 2014	172	through 2014	195
		Table 5-19 EFOF by unit type: January through September, 2007 through 2014	196
SECTION 5 Capacity Market	175	Table 5-20 PJM EFORd data for different unit types: January	
Table 5-1 The Capacity Market results were competitive	175	through September, 2007 through 2014	197
Table 5-2 RPM related MMU reports, 2013 through September, 2014	180	Table 5-21 OMC Outages: January through September 2014	199
Table 5-3 PJM installed capacity (By fuel source): January 1, May 31,	,	Table 5-22 Contribution to EFOF by unit type by cause: January	
June 1, and September 30, 2014	181	through September 2014	202
Table 5-4 Generation capacity changes: 2007/2008 through		Table 5-23 Contributions to Economic Outages: January through	
2013/2014	182	September 2014	203
Table 5-5 RSI results: 2014/2015 through 2017/2018 RPM Auctions	183	Table 5-24 PJM EFORd, XEFORd and EFORp data by unit type:	
Table 5-6 RPM imports: 2007/2008 through 2017/2018 RPM Base		January through September 2014	204
Residual Auctions	185		
Table 5-7 RPM load management statistics by LDA: June 1, 2013 to		CECTION C Domand Domana	207
June 1, 2017	186	SECTION 6 Demand Response	207
Table 5-8 RPM load management cleared capacity and ILR:		Table 6-1 Overview of demand response programs	210
2007/2008 through 2017/2018	187	Table 6-2 Economic program registrations on the last day of the	
Table 5-9 RPM load management statistics: June 1, 2007 to June 1,		month: January, 2010 through September, 2014	212
2017	187	Table 6-3 Maximum economic MW dispatched by registration per	
Table 5-10 ACR statistics: Auctions conducted in third quarter, 2014	188	month: January, 2010 through September, 2014	213
Table 5-11 Capacity prices: 2007/2008 through 2017/2018 RPM		Table 6-4 Credits paid to the PJM economic program participants:	
Auctions	189	January through September, 2010 through 2014	213
Table 5-12 RPM revenue by type: 2007/2008 through 2017/2018	190	Table 6-5 PJM economic program participation by zone: January	
Table 5-13 RPM revenue by calendar year: 2007 through 2018	191	through September, 2013 and 2014	214

Table 6-6 Settlements submitted by year in the economic program:		Table 6-23 PJM declared load management events: January through	
January through September, 2009 through 2014	214	September, 2014	222
Table 6-7 Participants and CSPs submitting settlements in the		Table 6-24 Demand response event performance: January 7, 2014	
economic program by year: January through September, 2009		(Event 1)	224
through 2014	215	Table 6-25 Demand response event performance: January 7, 2014	
Table 6-8 HHl and market concentration in the economic program:		(Event 2)	225
January through September, 2013 and 2014	215	Table 6-26 Demand response event performance: January 8, 2014	226
Table 6-9 Hourly frequency distribution of economic program		Table 6-27 Demand response event performance: January 22, 2014	226
MWh reductions and credits: January through September, 2013		Table 6-28 Demand response event performance: January 23, 2014	
and 2014	216	(Event 1)	227
Table 6-10 Frequency distribution of economic program zonal,		Table 6-29 Demand response event performance: January 23, 2014	
load-weighted, average LMP (By hours): January through		(Event 2)	227
September, 2013 and 2014	216	Table 6-30 Demand response event performance: January 24, 2014	228
Table 6-11 Result from net benefit tests: April, 2012 through		Table 6-31 Demand response event performance: March 4, 2014	229
September, 2014	217	Table 6-32 Aggregated load management event performance: January	
Table 6-12 Hours with price higher than NBT and DR occurrences in		through September, 2014	230
those hours: January through September, 2013 and 2014	217	Table 6-33 Distribution of participant event days and nominated	
Table 6-13 Zonal DR charge: January through September 2014	218	MW across ranges of performance levels across the events:	
Table 6-14 Monthly day-ahead and real-time DR charge: January		January through September, 2014	231
through September, 2013 and 2014	218	Table 6-34 Non-reporting locations and nominated ICAP: January	
Table 6-15 Zonal monthly capacity revenue: January through		through September, 2014 event days	232
September, 2014	219	Table 6-35 Distribution of registrations and associated MW in the	
Table 6-16 Energy efficiency resources by MW: 2012/2013 through		emergency full option across ranges of minimum dispatch prices:	
2014/2015 Delivery Year	220	2013/2014 Delivery Year	233
Table 6-17 Lead time by product type: 2014/2015 Delivery Year	220	Table 6-36 Distribution of registrations and associated MW in the	
Table 6-18 Reduction MW by each demand response method:		emergency full option across ranges of minimum dispatch prices:	
2013/2014 Delivery Year	220	2014/2015 Delivery Year	233
Table 6-19 Reduction MW by each demand response method:		Table 6-37 Energy reduction MWh and average real-time LMP during	
2014/2015 Delivery Year	221	demand response event days: January through September, 2014	235
Table 6-20 On-site generation fuel type by MW: 2013/2014		Table 6-38 Emergency revenue by event: January through	
Delivery Year	221	September, 2014	235
Table 6-21 On-site generation fuel type by MW: 2014/2015		Table 6-39 Penalty charges per zone: 2012/2013 and 2013/2014	
Delivery Year	221	Delivery Years	236
Table 6-22 Demand response cleared MW UCAP for PJM: 2011/2012			
through 2014/2015 Delivery Year	222		

xx Table of Contents © 2014 Monitoring Analytics, LLC

SECTION 7 Net Revenue	237	2	
Table 7-1 Average zonal operating costs: January through September, 2014  Table 7-2 Run hours: January through September, 2013 and 2014  Table 7-3 Energy Market net revenue for a new entrant gas-fired CT under economic dispatch (Dollars per installed MW-year): January through September, 2013 and 2014  Table 7-4 PJM Energy Market net revenue for a new entrant gas-fired CC under economic dispatch (Dollars per installed MW-year): January through September, 2013 and 2014  Table 7-5 PJM Energy Market net revenue for a new entrant CP (Dollars per installed MW-year): January through September,	240 241	<ul> <li>Table 8-3 RGGI CO<sub>2</sub> allowance auction prices and quantities in short tons and metric tonnes: 2009-2011 and 2012-2014 Compliance Periods</li> <li>Table 8-4 Renewable standards of PJM jurisdictions to 2024</li> <li>Table 8-5 Pennsylvania weighted average AEC price and AEC price for 2010 to 2013 Delivery Years</li> <li>Table 8-6 Solar renewable standards of PJM jurisdictions 2014 to 2024</li> <li>Table 8-7 Additional renewable standards of PJM jurisdictions 2014 to 2024</li> <li>Table 8-8 Renewable alternative compliance payments in PJM jurisdictions: As of September 30, 2014</li> </ul>	254 256 256 257 257
2013 and 2014  Table 7-6 PJM Energy Market net revenue for a new entrant DS  (Dollars per installed MW-year): January through September, 2013 and 2014	243	Table 8-9 Renewable resource generation by jurisdiction and renewable resource type (GWh): January through September 2014 Table 8-10 PJM renewable capacity by jurisdiction (MW), on September 30, 2014	258 259
Table 7-7 PJM Energy Market net revenue for a new entrant nuclear plant (Dollars per installed MW-year): January through September, 2013 and 2014 Table 7-8 Energy Market net revenue for a wind installation (Dollars	244	<ul> <li>Table 8-11 Renewable capacity by jurisdiction, non-PJM units registered in GATS (MW), on September 30, 2014</li> <li>Table 8-12 SO<sub>2</sub> emission controls (FGD) by fuel type (MW), as of September 30, 2014</li> </ul>	259
per installed MW-year): January through September, 2013 and 2014 Table 7-9 PSEG Energy Market net revenue for a solar installation	244	<ul> <li>Table 8-13 NO<sub>x</sub> emission controls by fuel type (MW), as of September 30, 2014</li> <li>Table 8-14 Particulate emission controls by fuel type (MW), as of September 30, 2014</li> </ul>	260
(Dollars per installed MW-year): January through September, 2013 and 2014	244	Table 8-15 CO <sub>2</sub> , SO <sub>2</sub> and NO <sub>x</sub> emissions by month (short and metric tons), by PJM units, January through September, 2014  Table 8-16 Capacity factor of wind units in PJM: January through	261
SECTION 8 Environmental and Renewable Energy Regulations	245	September 2014  Table 8-17 Capacity factor of wind units in PJM by month, 2013 and January through September, 2014	<ul><li>261</li><li>262</li></ul>
Table 8-1 Interim and final targets for CO <sub>2</sub> emissions goals for PJM states (lbs/MWh) Table 8-2 HEDD maximum NO <sub>x</sub> emission rates	252 253	Junuary emough September, 2017	202

SECTION 9 Interchange Transactions	265	Table 9-18 Net scheduled and actual PJM flows by interface (GWh):	
Table 9-1 Real-time scheduled net interchange volume by interface (GWh): January through September, 2014	270	January through September, 2014  Table 9-19 Net scheduled and actual PJM flows by interface pricing	285
Table 9-2 Real-time scheduled gross import volume by interface (GWh): January through September, 2014	271	point (GWh): January through September, 2014  Table 9-20 Net scheduled and actual PJM flows by interface pricing	286
Table 9-3 Real-time scheduled gross export volume by interface (GWh): January through September, 2014	271	point (GWh) (Adjusted for IMO Scheduled Interfaces): January through September, 2014  Table 0. 21 Net scheduled and actual BIM flows by interface and	286
Table 9-4 Real-time scheduled net interchange volume by interface pricing point (GWh): January through September, 2014	273	Table 9-21 Net scheduled and actual PJM flows by interface and interface pricing point (GWh): January through September, 2014 Table 9-22 Net scheduled and actual PJM flows by interface pricing	287
Table 9-5 Real-time scheduled gross import volume by interface pricing point (GWh): January through September, 2014	273	point and interface (GWh): January through September, 2014 Table 9-23 Distribution of hourly flows that are consistent and	288
Table 9-6 Real-time scheduled gross export volume by interface pricing point (GWh): January through September, 2014	274	inconsistent with price differences between PJM and MISO: January through September, 2014	290
Table 9-7 Day-Ahead scheduled net interchange volume by interface (GWh): January through September, 2014	275	Table 9-24 Distribution of hourly flows that are consistent and inconsistent with price differences between PJM and MISO:	230
Table 9-8 Day-Ahead scheduled gross import volume by interface (GWh): January through September, 2014	276	June 1, 2014 through September 30, 2014 Table 9-25 Distribution of hourly flows that are consistent and	291
Table 9-9 Day-Ahead scheduled gross export volume by interface (GWh): January through September, 2014	277	inconsistent with price differences between PJM and NYISO: January through September, 2014	292
Table 9-10 Day-ahead scheduled net interchange volume by interface pricing point (GWh): January through September, 2014	278	Table 9-26 Real-time average hourly LMP comparison for Duke, PEC and NCMPA: January through September, 2014	300
Table 9-11 Up-to congestion scheduled net interchange volume by interface pricing point (GWh): January through September, 2014	279	Table 9-27 Day-ahead average hourly LMP comparison for Duke, PEC and NCMPA: January through September, 2014	300
Fable 9-12 Day-ahead scheduled gross import volume by interface pricing point (GWh): January through September, 2014	280	Table 9-28 PJM MISO, and NYISO TLR procedures: January, 2011 through September, 2014	301
Fable 9-13 Up-to congestion scheduled gross import volume by interface pricing point (GWh): January through September, 2014	281	Table 9-29 Number of TLRs by TLR level by reliability coordinator: January through September, 2014	302
Fable 9-14 Day-ahead scheduled gross export volume by interface pricing point (GWh): January through September, 2014	282	Table 9-30 Monthly volume of cleared and submitted up-to congestion bids: January, 2009 through September, 2014	304
Table 9-15 Up-to congestion scheduled gross export volume by interface pricing point (GWh): January through September, 2014 Table 9-16 Active interfaces: January through September, 2014	283 283	Table 9-31 ITSCED/real-time LMP - PJM/NYIS interface price comparison (all intervals): January through September, 2014	306
Table 9-17 Active pricing points: January through September, 2014	284	Table 9-32 ITSCED/real-time LMP - PJM/NYIS interface price comparison (by interval): January through September, 2014	307

xxii Table of Contents © 2014 Monitoring Analytics, LLC

Table 9-33 ITSCED/real-time LMP - PJM/MISO interface price		Table 10-14 Weighted price of tier 1 synchronized reserve attributabl	e
comparison (all intervals): January through September, 2014	308	to a non-synchronized reserve price above zero; January through	
Table 9-34 ITSCED/real-time LMP - PJM/MISO interface price		September, 2014	331
comparison (by interval): January through September, 2014	308	Table 10-15 Tier 1 synchronized reserve spinning event response	
Table 9-35 Monthly uncollected congestion charges: January, 2010		costs, January through September, 2014	332
through September, 2014	309	Table 10-16 Default Tier 2 Synchronized Reserve Markets required	
		MW, RTO Zone and Mid-Atlantic Dominion Subzone	334
		Table 10-17 Three Pivotal Supplier Test Results for the RTO Zone	
SECTION 10 Ancillary Service Markets	313	and MAD Subzone, January through September, 2014	336
Table 10-1 The Regulation Market results were competitive	313	Table 10-18 Mid-Atlantic Dominion Subzone, weighted SRMCP and	
Table 10-2 The Synchronized Reserve Markets results were competitive		cleared MW: January through September 2014	339
Table 10-3 The Day-Ahead Scheduling Reserve Market results were		Table 10-19 RTO zone weighted SRMCP and cleared MW: January	
competitive	313	through September, 2014	340
Table 10-4 History of ancillary services costs per MWh of Load:		Table 10-20 Full RTO, RTO, Mid-Atlantic Subzone Tier 2	
January through September, 2003 through 2014	318	synchronized reserve MW, credits, price, and cost: January	
Table 10-5 Average tier 1 and tier 2 synchronized reserve, plus	3.0	through September, 2014	341
non-synchronized reserve used to satisfy the primary reserve		Table 10-21 Synchronized reserve events greater than 10 minutes,	
requirement, MAD Subzone: January through September, 2014	321	Tier 2 Response Compliance, RTO Reserve Zone, January through	
Table 10-6 Average tier 1 and tier 2 synchronized reserve, plus	321	September 2014	342
non-synchronized reserve used to satisfy the primary reserve		Table 10-22 Spinning events, 2010 through 2014	343
requirement, RTO Zone: January through September, 2014	321	Table 10-23 Non-synchronized reserve market HHIs, January	
Table 10-7 MW credited, price, cost, and all-in price for primary	321	through September 2014	345
reserve and its component products, full RTO Reserve Zone,		Table 10-24 Non-synchronized reserve market pivotal supply test,	
January through September, 2014	324	January through September 2014	345
Table 10-8 Monthly average market solution Tier 1 Synchronized	32.	Table 10-25 Full RTO, RTO, Mid-Atlantic Subzone non-synchronized	
Reserve identified hourly, January through September, 2014	325	reserve MW, credits, price, and cost: January through	
Table 10-9 Tier 1 compensation as currently implemented by PJM	327	September, 2014	347
Table 10-10 Tier 1 compensation as recommended by MMU	327	Table 10-26 PJM Day-Ahead Scheduling Reserve Market MW and	
Table 10-11 Dollar Impact of Paying Tier 1 Synchronized Reserve		clearing prices: January 2012 Through September 2014	348
the SRMCP When the NSRMCP Goes Above \$0	328	Table 10-27 PJM regulation capability, daily offer and hourly	
Table 10-12 Actual Payments Made to Tier 1 Resources Compared		eligible: January through September 2014	<b>35</b> 3
with Correct Tier 1 Payments	329	Table 10-28 PJM regulation provided by coal units	<b>35</b> 3
Table 10-13 MAD subzone ASO tier 1 estimate biasing, January		Table 10-29 Impact on PJM Regulation Market of currently	
through September, 2014	330	regulating units scheduled to retire through 2015	354

Table 10-30 PJM Regulation Market required MW and ratio of eligible		Table 11-3 Zonal and PJM real-time, load-weighted average LMP	
supply to requirement: January through September, 2013 and 2014	356	components (Dollars per MWh): January through September of 2013 and 2014	370
Table 10-31 PJM cleared regulation HHI: January through September	220	Table 11-4 Zonal and PJM day-ahead, load-weighted average LMP	370
2013 and 2014	357	components (Dollars per MWh): January through September of	
Table 10-32 Regulation market monthly three pivotal supplier results:		2013 and 2014	371
January through September, 2012 through 2014	358	Table 11-5 Hub real-time, load-weighted average LMP components	571
Table 10-33 Regulation sources: spot market, self-scheduled, bilateral	330	(Dollars per MWh): January through September of 2013 and 2014	<b>37</b> 1
purchases: January through September 2013 and 2014	360	Table 11-6 Hub day-ahead, load-weighted average LMP components	371
Table 10-34 Regulation sources by year: January through September,	300	(Dollars per MWh): January through September of 2013 and 2014	372
2010 through 2014	360	Table 11-7 Total PJM costs by component (Dollars (Millions)): January	312
Table 10-35 PJM Regulation Market monthly weighted average	300	·	372
market-clearing price, marginal unit opportunity cost and offer		Table 11-8 Total PJM congestion (Dollars (Millions)): January through	312
price (Dollars per MW): 2014	361		<b>37</b> 3
Table 10-36 Total regulation charges: January through September,	301	Table 11-9 Total PJM congestion costs by accounting category	373
2013 and 2014	362	(Dollars (Millions)): January through September of 2008	
Table 10-37 Components of regulation cost: 2014	362		373
Table 10-38 Comparison of average price and cost for PJM	302	Table 11-10 Total PJM congestion costs by accounting category by	3,,
Regulation, January through September, 2008 through 2014	363	market (Dollars (Millions)): January through September of 2008	
Table 10-39 Black start revenue requirement charges: January	303	· ·	374
through September, 2009 through 2014	364	Table 11-11 Monthly PJM congestion costs by market (Dollars	<i>.</i>
Table 10-40 Black start zonal charges for network transmission use:			374
January through September, 2013 and 2014	365	Table 11-12 Congestion summary (By facility type): January through	
Table 10-41 NERC CIP Costs: January through September 2014	365		376
Table 10-42 Reactive zonal charges for network transmission use:		Table 11-13 Congestion summary (By facility type): January through	
January through September 2013 and 2014	366		376
v		Table 11-14 Congestion event hours (Day-Ahead against Real-Time):	
			377
SECTION 11 Congestion and Marginal Losses	367	Table 11-15 Congestion event hours (Real-Time against Day-Ahead):	
Table 11-1 PJM real-time, load-weighted average LMP components			377
(Dollars per MWh): January through September of 2009		Table 11-16 Congestion summary (By facility voltage): January	
through 2014	369	through September of 2014	378
Table 11-2 PJM day-ahead, load-weighted average LMP		Table 11-17 Congestion summary (By facility voltage): January	
components (Dollars per MWh): January through September			378
of 2009 through 2014	370		

xxiv Table of Contents © 2014 Monitoring Analytics, LLC

Table 11–18 Top 25 constraints with frequent occurrence: January		Table 11–32 Total PJM marginal loss costs by accounting category by	
through September of 2013 and 2014	379	market (Dollars (Millions)): January through September of 2009	
Table 11-19 Top 25 constraints with largest year-to-year change in		through 2014	389
occurrence: January through September of 2013 and 2014	380	Table 11–33 Monthly marginal loss costs by market (Dollars	
Table 11-20 Top 25 constraints affecting PJM congestion costs (By		(Millions)): January through September of 2013 and 2014	390
facility): January through September of 2014	381	Table 11-34 Marginal loss credits (Dollars (Millions)): January through	
Table 11-21 Top 25 constraints affecting PJM congestion costs (By		September of 2009 through 2014	391
facility): January through September of 2013	382	Table 11-35 Total PJM costs by energy component (Dollars	
Table 11-22 Top 20 congestion cost impacts from MISO flowgates		(Millions)): January through September of 2009 through 2014	391
affecting PJM dispatch (By facility): January through		Table 11-36 Total PJM energy costs by accounting category (Dollars	
September of 2014	384	(Millions)):	
Table 11-23 Top 20 congestion cost impacts from MISO flowgates		January through September of 2009 through 2014	392
affecting PJM dispatch (By facility): January through		Table 11-37 Total PJM energy costs by market category (Dollars	
September of 2013	385	(Millions)): January through September of 2009 through 2014	392
Table 11-24 Top two congestion cost impacts from NYISO flowgates		Table 11-38 Monthly energy costs by market type (Dollars (Millions))	:
affecting PJM dispatch (By facility): January through September		January through September of 2013 and 2014	392
of 2014	386		
Table 11-25 Top two congestion cost impacts from NYISO flowgates			
affecting PJM dispatch (By facility): January through September		SECTION 12 Generation and Transmission Planning	395
of 2013	386	Table 12-1 Year-to-year capacity additions from PJM generation	
Table 11-26 Regional constraints summary (By facility): January		queue: Calendar years 2000 through 2014	397
through September of 2014	386	Table 12-2 Queue comparison by expected completion year (MW):	
Table 11-27 Regional constraints summary (By facility): January		June 30, 2014 vs. September 30, 2014	398
through September of 2013	387	Table 12-3 Change in project status (MW): June 30, 2014 vs.	
Table 11-28 Congestion cost by type of participant: January through		September 30, 2014	398
September of 2014	387	Table 12-4 Capacity in PJM queues (MW): At September 30, 2014	399
Table 11-29 Congestion cost by type of participant: January through		Table 12-5 Queue capacity by control zone and LDA (MW) at	
September of 2013	388	September 30, 2014	400
Table 11-30 Total marginal loss component costs (Dollars (Millions)):		Table 12-6 Summary of PJM unit retirements (MW): 2011 through	
January through September of 2009 through 2014	389	2019	400
Table 11-31 Total PJM marginal loss costs by accounting category		Table 12-7 Planned deactivations of PJM units, as of	
(Dollars (Millions)): January through September of 2009		September 30, 2014	402
through 2014	389	Table 12-8 Retirements by fuel type, 2011 through 2019	402
-		Table 12-9 Unit deactivations between January 1, 2014 and	
		September 30, 2014	403
		p	

Table 12-10 Existing PJM capacity: at September 30, 2014 (By zone and		Table 13-10 Monthly Balance of Planning Period FTR Auction	
unit type (MW))	404	revenue: January through September 2014	427
Table 12-11 PJM capacity (MW) by age (years): at September 30, 2014	404	Table 13-11 Total annual PJM FTR revenue detail (Dollars (Millions)):	
Table 12-12 Comparison of generators 40 years and older with slated		Planning periods 2013 to 2014 and 2014 to 2015	430
capacity additions (MW) through 2024, as of September 30, 2014	406	Table 13-12 Unallocated congestion charges: Planning period 2012	
Table 12-13 PJM generation planning process	407	to 2013 through 2014 to 2015	430
Γable 12-14 Milestone due at time of withdrawal	407	Table 13-13 Monthly FTR accounting summary (Dollars (Millions)):	
Table 12-15 Average project queue times (days) at September 30,		Planning period 2013 to 2014 and 2014 to 2015	431
2014	408	Table 13-14 PJM reported FTR payout ratio by planning period	432
Table 12-16 PJM generation planning summary: at September 30,		Table 13-15 End of planning period FTR uplift charge example	433
2014	408	Table 13-16 PJM Reported and Actual Monthly Payout Ratios:	
		Calendar year 2014	433
CROTTON 40 Ft 1 J T 1 J 1 J 1		Table 13-17 Example of FTR payouts from portfolio netting and	
SECTION 13 Financial Transmission and Auction		without portfolio netting	435
Revenue Rights	411	Table 13-18 Monthly positive and negative target allocations and	
Table 13-1 The FTR Auction Markets results were competitive	411	payout ratios with and without hourly netting: Planning period	
Table 13-2 Monthly Balance of Planning Period FTR Auction patterns		2013 to 2014 and 2014 to 2015	435
of ownership by FTR direction: January through September 2014	419	Table 13-19 Example implementation of counter flow adjustment	
Table 13-3 Daily FTR net position ownership by FTR direction:		method 436	
January through September 2014	420	Table 13-20 Counter flow FTR payout ratio adjustment impacts	437
Table 13-4 Monthly Balance of Planning Period FTR Auction market		Table 13-21 Historic Stage 1B and Stage 2 ARR Allocations from the	
volume: January through September 2014	423	2011 to 2012 through 2014 to 2015 planning periods	441
Table 13-5 Monthly Balance of Planning Period FTR Auction buy-bid,		Table 13-22 ARRs and ARR revenue automatically reassigned for	
bid and cleared volume (MW per period): January through		network load changes by control zone: June 1, 2013, through	
September 2014	424	September 30, 2014	442
Table 13-6 Secondary bilateral FTR market volume: Planning periods		Table 13-23 Residual ARR allocation volume and target allocation	443
2013 to 2014 and 2014 to 2015	425	Table 13-24 Projected ARR revenue adequacy (Dollars (Millions)):	
Table 13-7 Monthly Balance of Planning Period FTR Auction cleared,		Planning periods 2012 to 2013 and 2013 to 2014	443
weighted-average, buy-bid price per period (Dollars per MW):		Table 13-25 ARR and self-scheduled FTR congestion offset	4.45
January through September 2014	426	(in millions) by control zone: 2014 to 2015 planning period	445
Table 13-8 FTR profits by organization type and FTR direction:		Table 13-26 ARR and FTR congestion offset (in millions) by control	4.46
January through September 2014	426	zone: 2014 to 2014 planning period	446
Table 13-9 Monthly FTR profits by organization type: January		Table 13-27 ARR and FTR congestion hedging (in millions): Planning	111
through September 2014	426	periods 2013 to 2014 and 2014 to 2015	446

xxvi Table of Contents © 2014 Monitoring Analytics, LLC