45

## Table of Contents From Section 10, Ancillary Services 46 From Section 12, Planning 46 Complete List of MMU Recommendations 46 **Preface** Section 3, Energy Market 46 Section 4, Energy Uplift 47 **SECTION 1 Introduction** Section 5, Capacity 48 01 2014 in Review Section 6, Demand Response 49 PJM Market Summary Statistics 3 Section 7, Net Revenue 49 3 PJM Market Background Section 8, Environmental 49 Conclusions 4 Section 9, Interchange Transactions 49 Role of MMU 8 Section 10, Ancillary Services 50 Reporting 8 Section 11, Congestion and Marginal Losses 50 8 Monitoring Section 12, Planning 50 Market Design 9 Section 13, FTRs and ARRs 51 Prioritized Summary of New Recommendations 9 Total Price of Wholesale Power 10 **SECTION 3 Energy Market** 53 Components of Total Price 10 Section Overviews 12 **Overview** 54 Overview: Section 3, "Energy Market" 12 **Market Structure** 54 Overview: Section 4, "Energy Uplift" 18 Market Behavior 55 Overview: Section 5, "Capacity Market" 21 Market Performance 56 Overview: Section 6, "Demand Response" 24 Scarcity 57 Overview: Section 7, "Net Revenue" 26 Recommendations 57 Overview: Section 8, "Environmental and Renewables" 27 Conclusion 58 Overview: Section 9, "Interchange Transactions" 29 Market Structure 60 Overview: Section 10, "Ancillary Services" 31 **Market Concentration** 60 Overview: Section 12, "Planning" 38 Ownership of Marginal Resources 61 Overview: Section 13, "FTR and ARRs" 39 Type of Marginal Resources 62 Supply 63 72 **SECTION 2 Recommendations** 45 Supply and Demand: Load and Spot Market 80 Summary of New Recommendations 45 Market Behavior 82 New Recommendations 45 Offer Capping for Local Market Power 82

From Section 3, Energy Market

Offer Capping for Local Market Power	83	Energy Uplift Recommendations	138
Markup	85	January through March 2014 Energy Uplift Charges Increase	138
Frequently Mitigated Units and Associated Units	86	Recommendations	138
Virtual Offers and Bids	89	Conclusion	139
Generator Offers	98	Energy Uplift	140
Market Performance	99	Credits and Charges Categories	140
Markup	99	Energy Uplift Results	142
Prices	106	Energy Uplift Charges	142
Scarcity	120	Operating Reserve Rates	145
Emergency procedures	120	Reactive Services Rates	148
Scarcity and Scarcity Pricing	124	Balancing Operating Reserve Determinants	149
January 6, 2014	124	Energy Uplift Credits	151
January 7, 2014	124	Characteristics of Credits	151
Analysis of emergency events in January 2014	124	Types of Units	151
FERC Waivers	125	Concentration of Energy Uplift Credits	152
Generator outages	126	Economic and Noneconomic Generation	153
Capacity market incentives	127	Geography of Charges and Credits	156
Natural gas supply and prices	128	Energy Uplift Issues	158
Conservative operations and energy uplift costs	128	Lost Opportunity Cost Credits	158
Demand response	129	Black Start Service Units	161
Day-ahead and real-time LMP	129	Reactive / Voltage Support Units	161
Designation of maximum emergency MW	131	Confidentiality of Energy Uplift Information	163
Participant behavior during cold weather days in January	131	Energy Uplift Recommendations	163
Real-time markup on high demand days in January	133	Credits Recommendations	163
Marginal fuel	134	Allocation Recommendations	166
Interchange transactions	134	Quantifiable Recommendations Impact	170
		January through March 2014 Energy Uplift Charges Increase	170
CECTION 4 France 11-1:0 (Occurs the December)	107	Energy Uplift and Conservative Operations	172
SECTION 4 Energy Uplift (Operating Reserves)	137	Lost Opportunity Cost Credits	173
Overview	137		
Energy Uplift Results	137	SECTION E Conseits Market	175
Characteristics of Credits	137	SECTION 5 Capacity Market	175
Geography of Charges and Credits	137	Overview	175
Energy Uplift Issues	138	RPM Capacity Market	175

Generator Performance	177	New Entrant Nuclear Plant	229
Recommendations	177	New Entrant Wind Installation	229
Conclusion	178	New Entrant Solar Installation	230
Installed Capacity	180		
RPM Capacity Market	180		
Market Structure	180	SECTION 8 Environmental and Renewable Energy	
Market Conduct	186	Regulations	231
Market Performance	186	Overview	231
Generator Performance	190	Federal Environmental Regulation	231
Capacity Factor	191	State Environmental Regulation	232
Generator Performance Factors	191	Emissions Controls in PJM Markets	232
Generator Forced Outage Rates	193	State Renewable Portfolio Standards	233
		Conclusion 2	33
CTOTTON - D		Federal Environmental Regulation	233
SECTION 6 Demand Response	203	Control of Mercury and Other Hazardous Air Pollutants	233
Overview	203	Air Quality Standards: Control of NO, SO, and O, Emissions	
Recommendations	203	Allowances	234
Conclusion	204	Emission Standards for Reciprocating Internal Combustion	
PJM Demand Response Programs	205	Engines	235
Participation in Demand Response Programs	205	Regulation of Greenhouse Gas Emissions	236
Economic Program	206	Federal Regulation of Environmental Impacts on Water	236
Emergency Program	210	State Environmental Regulation	237
		New Jersey High Electric Demand Day (HEDD) Rules	237
CDOMON - N. A.D.	222	State Regulation of Greenhouse Gas Emissions	237
SECTION 7 Net Revenue	223	Renewable Portfolio Standards	239
Overview	223	Emissions Controlled Capacity and Renewables in PJM Markets	244
Net Revenue	223	Emission Controlled Capacity in the PJM Region	244
Conclusion	223	Wind Units	245
Net Revenue	223	Solar Units	247
Theoretical Energy Market Net Revenue	224		
New Entrant Combustion Turbine	226		
New Entrant Combined Cycle	227		
New Entrant Coal Plant	228		
New Entrant Diesel	228		

SECTION 9 Interchange Transactions	249	Elimination of Ontario Interface Pricing Point	285
Overview	249	PJM and NYISO Coordinated Interchange Transaction Proposal	286
Interchange Transaction Activity	249	Willing to Pay Congestion and Not Willing to Pay Congestion	288
Interactions with Bordering Areas	249	Spot Imports	288
Recommendations	250	Real-Time Dispatchable Transactions	289
Conclusion	251		
Interchange Transaction Activity	251	CDOTION AS A WAY OF A MAIN	
Aggregate Imports and Exports	251	SECTION 10 Ancillary Service Markets	291
Real-Time Interface Imports and Exports	253	Overview	292
Real-Time Interface Pricing Point Imports and Exports	255	Regulation Market	292
Day-Ahead Interface Imports and Exports	257	Synchronized Reserve Market	293
Day-Ahead Interface Pricing Point Imports and Exports	259	Non-Synchronized Reserve Market	294
Loop Flows	264	Day-Ahead Scheduling Reserve (DASR)	295
PJM and MISO Interface Prices	269	Black Start Service	295
PJM and NYISO Interface Prices	271	Reactive	295
Summary of Interface Prices between PJM and Organized Markets	273	Ancillary Services Costs per MWh of Load: January through	
Neptune Underwater Transmission Line to Long Island, New York	273	March, 2003 through 2014	296
Linden Variable Frequency Transformer (VFT) facility	274	Recommendations	296
Hudson Direct Current (DC) Merchant Transmission Line	275	Conclusion	297
Operating Agreements with Bordering Areas	276	Regulation Market	297
PJM and MISO Joint Operating Agreement	276	Market Design	297
PJM and New York Independent System Operator Joint		Market Structure	300
Operating Agreement (JOA)	277	Market Conduct	304
PJM, MISO and TVA Joint Reliability Coordination Agreement		Market Performance	305
(JRCA)	279	Primary Reserve	307
PJM and Progress Energy Carolinas, Inc. Joint Operating		Requirements	307
Agreement	279	Synchronized Reserve Market	310
PJM and VACAR South Reliability Coordination Agreement	280	Market Structure	310
Interface Pricing Agreements with Individual Balancing Authoritie	s 280	Market Behavior	314
Other Agreements with Bordering Areas	280	Market Performance	315
Interchange Transaction Issues	281	Non-Synchronized Reserve Market	321
PJM Transmission Loading Relief Procedures (TLRs)	281	Day-Ahead Scheduling Reserve (DASR)	322
Up-To Congestion	282	Market Structure	323
Sham Scheduling	285	Market Conduct	323

Market Performance	323	SECTION 12 Generation and Transmission Planning	361
Black Start Service	325	Overview	361
Reactive Service	328	Planned Generation and Retirements	361
		Generation and Transmission Interconnection Planning Process	361
SECTION 11 Congestion and Marginal Losses	331	Backbone Facilities	361
SECTION 11 Congestion and Marginal Losses		Recommendations	361
Overview	331	Conclusion	362
Congestion Cost	331	Planned Generation and Retirements	362
Marginal Loss Cost	332	Planned Generation Additions	362
Energy Cost	333	Planned Retirements	365
Conclusion	333	Generation Mix	368
Locational Marginal Price (LMP)	333	Generation and Transmission Interconnection Planning Process	371
Components	333	Interconnection Study Phase	371
Zonal Components	335	Backbone Facilities	373
Hub Components	337		
Component Costs	338		
Congestion	338	SECTION 13 Financial Transmission and Auction	
Congestion Accounting	338	Revenue Rights	375
Total Congestion	338	Overview	375
Congested Facilities	340	Financial Transmission Rights	375
Congestion by Facility Type and Voltage	340	Auction Revenue Rights	377
Constraint Duration	344	Recommendations	377
Constraint Costs	346	Conclusion	378
Congestion-Event Summary for MISO Flowgates	349	Financial Transmission Rights	380
Congestion-Event Summary for NYISO Flowgates	351	Market Structure	381
Congestion-Event Summary for the 500 kV System	352	Market Structure  Market Behavior	383
Congestion Costs by Physical and Financial Participants	353	Market Performance	385
Marginal Losses	354		396
Marginal Loss Accounting	354	Revenue Adequacy Issues and Solutions Auction Revenue Rights	401
Total Marginal Loss Costs	354	Market Structure	401
Energy Costs	357	Market Performance	405
Energy Accounting	357	ויומותכנ דכווטוווומוונכ	405
Total Energy Costs	357		
January High Load Days	359		

Figures		Figure 3-13 Distribution of PJM real-time accounting load plus	
		exports: January through March of 2013 and 2014	75
		Figure 3-14 PJM real-time monthly average hourly load: January	7.
SECTION 1 Introduction	1	2013 through March 2014  Figure 3, 15 PIM heating and applied degree days, language 2013	76
Figure 1-1 PJM's footprint and its 20 control zones	3	Figure 3-15 PJM heating and cooling degree days: January 2013 through March 2014	76
Figure 1-2 PJM reported monthly billings (\$ Billions): January 2008		Figure 3-16 Distribution of PJM day-ahead demand plus exports:	,
through March 2014	4	January through March of 2013 and 2014	77
		Figure 3-17 PJM day-ahead monthly average hourly demand:	
		January 2013 through March 2014	78
SECTION 3 Energy Market	53	Figure 3-18 Day-ahead and real-time demand (Average hourly	
Figure 3-1 Fuel source distribution in unit segments: January		volumes): January through March of 2014	80
through March, 2014	61	Figure 3-19 Difference between day-ahead and real-time demand	
Figure 3-2 PJM hourly Energy Market HHI: January through March,		(Average daily volumes): January 2013 through March 2014	80
2014	61	Figure 3-20 Frequently mitigated units and associated units total	
Figure 3-3 Average PJM aggregate real-time generation supply curves	:	months eligible: February, 2006 through March, 2014	87
January through March of 2013 and 2014	64	Figure 3-21 Frequently mitigated units and associated units	
Figure 3-4 Distribution of PJM real-time generation plus imports:		(By month): February, 2006 through March, 2014	88
January through March of 2013 and 2014	66	Figure 3-22 PJM day-ahead aggregate supply curves:	
Figure 3-5 PJM real-time average monthly hourly generation: January		2014 example day	90
2013 through March 2014	67	Figure 3-23 Hourly number of bid and cleared INC, DEC and Up-to	
Figure 3-6 Distribution of PJM day-ahead supply plus imports: Januar	У	Congestion bids (MW) by month: January 2005 through March	
through March of 2013 and 2014	68	2014	92
Figure 3-7 PJM day-ahead monthly average hourly supply: January		Figure 3-24 PJM cleared up-to congestion transactions by type (MW)	:
2013 through March 2014	69	January 2005 through March 2014	97
Figure 3-8 Day-ahead and real-time supply (Average hourly volumes):		Figure 3-25 Average LMP for the PJM Real-Time Energy Market:	
January through March of 2014	71	January through March of 2013 and 2014	107
Figure 3-9 Difference between day-ahead and real-time supply		Figure 3-26 PJM real-time, monthly and annual, load-weighted,	
(Average daily volumes): January 2013 through March of 2014	71	average LMP: 1999 through March of 2014	109
Figure 3-10 Map of PJM real-time generation less real-time load by		Figure 3-27 Spot average fuel price comparison with fuel delivery	
zone: January through March of 2014	72	charges: 2012 through 2014 (\$/MMBtu)	109
Figure 3-11 PJM footprint calendar year peak loads: January through		Figure 3-28 Average LMP for the PJM Day-Ahead Energy Market:	
March of 1999 to 2014	73	January through March of 2013 and 2014	112
Figure 3-12 PJM peak-load comparison: Tuesday, January 7, 2014,		Figure 3-29 Day-ahead, monthly and annual, load-weighted,	
and Tuesday, January 22, 2013	74	average LMP: 2000 through March of 2014	113

Figure 3-30 Node hours, by hour, that day-ahead and real-time		Figure 4-2 Daily balancing operating reserve reliability rates	
LMP was closer with or without UTC in PJM's May Study:		(\$/MWh): 2013 and 2014	146
May 2, 4, 22, 23 and 27	116	Figure 4-3 Daily balancing operating reserve deviation rates	
Figure 3-31 Real-time hourly LMP minus day-ahead hourly LMP:		(\$/MWh): 2013 and 2014	147
January through March of 2014	119	Figure 4-4 Daily lost opportunity cost and canceled resources rates	
Figure 3-32 Monthly average of real-time minus day-ahead LMP:		(\$/MWh): 2013 and 2014	147
January through March of 2014	119	Figure 4-5 Daily reactive transfer interface support rates (\$/MWh):	
Figure 3-33 PJM system hourly average LMP: January through		2013 and 2014	149
March of 2014	120	Figure 4-6 Energy uplift charges change from January through March	1
Figure 3-34 Generator outages in January 2014 by type of outage	126	2013 to January through March 2014 by category	171
Figure 3-35 Generator outages in January 2014 by unit fuel source	127	Figure 4-7 Day-ahead operating reserve charges change from January	
Figure 3-36 Forced outage MW in January 2014 by cause	127	through March 2013 to January through March 2014 by category	172
Figure 3-37 Average daily delivered price for natural gas:		Figure 4-8 Balancing operating reserve charges change from January	
January 2014 (\$/MMBtu)	128	through March 2013 to January through March 2014 by category	172
Figure 3-38 Conservative operations generation and energy uplift		Figure 4-9 Critical January days peak and off peak output	<b>17</b> 3
costs: January 2014	129	Figure 4-10 BOR and LOC Generation: January through March 2014	174
Figure 3-39 PJM real-time and day-ahead hourly LMP: January 2014	130		
Figure 3-40 Real-time hourly LMP minus day-ahead hourly LMP:		CDCDION F O 14 M 1 4	4
January 2014	130	SECTION 5 Capacity Market	175
Figure 3-41 Distributions of Offer Prices, All Units: January 2014	132	Figure 5-1 Map of PJM Locational Deliverability Areas	182
Figure 3-42 Distributions of Offer Prices, Gas Units: January 2014	132	Figure 5-2 Map of PJM RPM EMAAC subzonal LDAs	182
Figure 3-43 Distributions of Offer Prices, Coal Units: January 2014	133	Figure 5-3 Map of PJM RPM ATSI subzonal LDA	183
Figure 3-44 Hourly Markup Component of PJM's system-wide		Figure 5-4 History of PJM capacity prices: 1999/2000 through	
real-time LMP: January 2014	133	2016/2017	188
Figure 3-45 Daily Markup Contribution to the Real-time		Figure 5-5 Map of RPM capacity prices: 2013/2014 through	
Load-weighted LMP by Fuel Type: January 2014	134	2016/2017	189
Figure 3-46 Percentage Contribution of Fuel Cost to Daily		Figure 5-6 PJM outages (MW): January 2012 through March 2014	191
Load-weighted Real Time LMP: January 2014	134	Figure 5-7 PJM equivalent outage and availability factors: January	
		through March, 2007 to 2014	192
		Figure 5-8 Trends in the PJM equivalent demand forced outage rate	
SECTION 4 Energy Uplift (Operating Reserves)	137	(EFORd): January through March, 2007 through 2014	194
Figure 4-1 Daily day-ahead operating reserve rate (\$/MWh): 2013		Figure 5-9 PJM distribution of EFORd data by unit type: January	
and 2014	146	through March 2014	194

Figure 5-10 PJM EFORd, XEFORd and EFORp: January through	201	SECTION 9 Interchange Transactions	249
March 2014 Figure 5–11 PJM monthly generator performance factors: January	201	Figure 9-1 PJM real-time and day-ahead scheduled imports and	
through March 2014	201	exports: January through March, 2014	252
		Figure 9-2 PJM real-time and day-ahead scheduled import and export transaction volume history: 1999 through March, 2014	253
CHOTION - D		Figure 9-3 PJM's footprint and its external interfaces	264
SECTION 6 Demand Response	203	Figure 9-4 Real-time and day-ahead daily hourly average price	204
Figure 6-1 Demand response revenue by market: 2002 through March, 2014	206	difference (MISO Interface minus PJM/MISO): January through March, 2014	271
Figure 6-2 Economic program credits and MWh by month: 2010		Figure 9-5 Real-time and day-ahead daily hourly average price	2/1
through March, 2014	208	difference (NY proxy - PJM/NYIS): January through March, 2014	272
Figure 6-3 Distribution of participant event days across ranges of		Figure 9-6 PJM, NYISO and MISO real-time and day-ahead border	
performance levels across the events: January through March, 201	4 217	price averages: January through March, 2014	273
		Figure 9-7 Neptune hourly average flow: January through	
SECTION 7 Net Revenue	223	March, 2014	274
	223	Figure 9-8 Linden hourly average flow: January through	
Figure 7-1 Energy Market net revenue factor trends: 2009 through March 2014	224	March, 2014	275
Figure 7-2 Average zonal operating costs: 2009 through March 2014	224	Figure 9-9 Hudson hourly average flow: January through	076
rigure 7 2 / Werage Zonar operating costs. 2005 through March 2014	220	March, 2014 Figure 9-10 Credits for coordinated congestion management:	276
		January through March, 2014	277
SECTION 8 Environmental and Renewable Energy		Figure 9-11 Credits for coordinated congestion management	211
Regulations	231	(flowgates): January through March, 2014	278
Figure 8-1 Spot monthly average emission price comparison: 2013		Figure 9-12 Credits for coordinated congestion management	
and January through March of 2014	238	(Ramapo PARs): January through March, 2014	279
Figure 8-2 Average hourly real-time generation of wind units in		Figure 9-13 Monthly up-to congestion cleared bids in MWh:	
PJM: January through March, 2014	245	January, 2005 through March, 2014	283
Figure 8-3 Average hourly day-ahead generation of wind units in		Figure 9-14 Spot import service utilization: January, 2009 through	
PJM: January through March 2014	246	March, 2014	289
Figure 8-4 Marginal fuel at time of wind generation in PJM:	0.47		
January through March 2014  Figure 9. F. Average hourly real, time generation of solar units in	247		
Figure 8-5 Average hourly real-time generation of solar units in PJM: January through March 2014	247		
Tom January anough match 2017	217		

SECTION 10 Ancillary Service Markets	291	Figure 10-15 RTO Zone average daily tier 2 synchronized reserve	
Figure 10-1 Hourly average performance score by unit type and regulation signal type: 2013	299	offer by unit type (MW): January through March 2012 – 2014 Figure 10–16 Comparison of Mid-Atlantic Dominion Subzone synchronized reserve weighted average clearing price and cost	315
Figure 10-2 Daily average marginal benefit factor and mileage ratio:  January through March 2014	299	(Dollars per MW): January through March 2014 Figure 10-17 Spinning events duration distribution curve, January	317
Figure 10-3 Daily average actual cleared MW of regulation, effective cleared MW of regulation, and average performance score; all cleared regulation: January through March 2014 Figure 10-4 RegD: Daily average actual cleared MW of regulation,	301	through March 2011 through 2014 Figure 10-18 Daily average MAD Subzone Non-Synchronized Reserve Market clearing price and MW purchased: January through March	
effective cleared MW of regulation, and average performance score; RegD units: January through March 2014 Figure 10-5 PJM Regulation Market HHI distribution: January	301	2014 322 Figure 10-19 Daily average RTO Zone Non-Synchronized Reserve Market clearing price and MW purchased: January through	
through March 2013 and 2014	303	March 2014	322
Figure 10-6 Off peak and on peak regulation levels: January through March 2014	304	Figure 10-20 Daily average components of DASR clearing price, marginal unit offer and LOC: January through March 2014 Figure 10-21 Daily average DASR prices and MW by classification:	324
Figure 10-7 PJM Regulation Market daily weighted average market- clearing price, marginal unit opportunity cost and offer price (Dollars per MW): 2014	306	January through March, 2014	325
Figure 10-8 Comparison of monthly average RegA and RegD RMCP	300	SECTION 11 Congestion and Marginal Losses	331
Credits per Effective MW: October 2012 through March 2014	307	Figure 11-1 PJM monthly total congestion cost (Dollars (Millions)):	551
Figure 10-9 PJM RTO geography and primary reserve requirement: January through June 2013	308	2009 through March of 2014 Figure 11-2 Location of the top 10 constraints affecting PJM	340
Figure 10-10 Mid-Atlantic Dominion Subzone primary reserve MW	200	congestion costs: January through March of 2014	348
by source (Daily Averages): January through March 2014 Figure 10-11 Mid-Atlantic Dominion Subzone daily average market	309	Figure 11-3 PJM monthly marginal loss costs (Dollars (Millions)):	
clearing price: January through March 2014	309	January 2009 through March 2014	356
Figure 10-12 Mid-Atlantic Dominion Reserve Subzone Monthly average synchronized reserve required vs. tier 2 synchronized		Figure 11-4 PJM monthly energy costs (Dollars (Millions)):  January 2009 through March 2014  Figure 11 F PJM total marginal loss cost (Dollars (Millions)):	359
reserve scheduled MW: January through March 2014	313	Figure 11-5 PJM total marginal loss cost (Dollars (Millions)):  January of 2013 and 2014	359
Figure 10-13 Tier 2 synchronized reserve daily average offer volume (MW): January through March 2014 Figure 10-14 Mid-Atlantic Dominion Subzone average daily tier 2	314	Figure 11-6 PJM total congestion cost (Dollars (Millions)): January of 2013 and 2014	360
synchronized reserve offer by unit type (MW): January through			
March 2012 – 2014	315		

SECTION 12 Generation and Transmission Planning	361
Figure 12-1 Map of PJM unit retirements: 2011 through 2019	366
Figure 12-2 PJM capacity (MW) by age (years): at March 31, 2014	369
SECTION 13 Financial Transmission and Auction	
	375
Figure 13-1 Illustration of INC/DEC FTR forfeiture rule	383
Figure 13-2 Monthly FTR forfeitures for physical and financial	
participants: June 2010 through March 2014	384
Figure 13-3 FTR forfeitures for INCs/DECs and INCs/DECs/UTCs	
for both the PJM and MMU methods: January 2013 through	
March 2014	384
Figure 13-4 Cleared auction volume (MW) as a percent of total FTR	
cleared volume by calendar month: June 2004 through March	
2014	386
Figure 13-5 Long Term, Annual and Monthly FTR Auction bid and	
cleared volume: June 2003 through March 2014	387
Figure 13-6 Ten largest positive and negative revenue producing	
FTR sinks purchased in the Monthly Balance of Planning Period	
FTR Auctions: planning period 2013 to 2014 through	
March 31, 2014	389
Figure 13-7 Ten largest positive and negative revenue producing FTR	
sources purchased in the Monthly Balance of Planning Period FTR	
Auctions: planning period 2013 to 2014 through March 31, 2014	390
Figure 13-8 Ten largest positive and negative FTR target allocations	
summed by sink: 2013 to 2014 planning period through	
March 31, 2014	390
Figure 13-9 Ten largest positive and negative FTR target allocations	
summed by source: 2013 to 2014 planning period through	
March 31, 2014	391
Figure 13-10 FTR payout ratio by month, excluding and including	
excess revenue distribution: January 2004 through March 2014	394

Figure 13-11 FTR surplus and the collected Day-Ahead, Balancing and	
Total congestion: January 2005 through March 2014	400
Figure 13-12 FTR target allocation compared to sources of positive	
and negative congestion revenue	400
Figure 13-13 Annual FTR Auction prices vs. average day-ahead and	
real-time congestion for all control zones relative to the	
Western Hub: 2013 to 2014 planning period through	
March 31, 2014	407
Figure 13–13 Annual FTR Auction prices vs. average day-ahead and real-time congestion for all control zones relative to the Western Hub: 2013 to 2014 planning period through	

## **Tables**

		2013 and 2014	62
SECTION 1 Introduction	1	Table 3-6 Type of fuel used (By real-time marginal units): January	
	•	through March 2013 and January through March 2014	63
Table 1-1 PJM Market Summary Statistics, January through		Table 3-7 Day-ahead marginal resources by type/fuel: January	
March, 2013 and 2014	3	through March 2013 and 2014	63
Table 1-2 The Energy Market results were competitive	5	Table 3-8 PJM generation (By fuel source (GWh)): January through	
Table 1-3 The Capacity Market results were competitive	6	March of 2013 and 2014	64
Table 1-4 The Regulation Market results were competitive	6	Table 3-9 Monthly PJM generation (By fuel source (GWh)): January	
Table 1-5 The Synchronized Reserve Markets results were competitive	7	through March of 2014	65
Table 1-6 The Day-Ahead Scheduling Reserve Market results were		Table 3-10 PJM real-time average hourly generation and real-time	
competitive	7	average hourly generation plus average hourly imports: January	
Table 1-7 The FTR Auction Markets results were competitive	7	through March of 2000 through 2014	67
Table 1-8 Prioritized summary of new recommendations: January		Table 3-11 PJM day-ahead average hourly supply and day-ahead	
through March, 2014	10	average hourly supply plus average hourly imports: January	
Table 1-9 Total price per MWh by category: January through		through March of 2000 through 2014	69
March, 2013 and 2014	11	Table 3-12 Day-ahead and real-time supply (MWh): January through	
		March of 2013 and 2014	70
		Table 3-13 PJM real-time generation less real-time load by zone	
SECTION 2 Recommendations	45	(GWh): January through March of 2013 and 2014	72
Table 2-1 Prioritized summary of new recommendations: January		Table 3-14 Actual PJM footprint peak loads: January through March	
through March, 2014	45	of 1999 to 2014	73
		Table 3-15 PJM real-time average hourly load and real-time average	
		hourly load plus average hourly exports: January through March	
SECTION 3 Energy Market	53	of 1998 through 2014	75
Table 3-1 The Energy Market results were competitive	53	Table 3-16 PJM day-ahead average demand and day-ahead average	
Table 3-2 PJM hourly Energy Market HHI: January through March,		hourly demand plus average hourly exports: January through	
2013 and 2014	60	March of 2000 through 2014	78
Table 3-3 PJM hourly Energy Market HHI (By supply segment):		Table 3-17 Cleared day-ahead and real-time demand (MWh):	
2013 and 2014	60	January through March of 2013 and 2014	79
Table 3-4 Marginal unit contribution to PJM real-time, load-weighted		Table 3–18 Monthly average percentage of real-time self-supply load,	
LMP (By parent company): January through March 2013 and 2014	1 62	bilateral-supply load and spot-supply load based on parent	
( )		companies: 2013 through 2014	81

Table 3-5 Marginal resource contribution to PJM day-ahead,

load-weighted LMP (By parent company): January through March

Table 3-19 Monthly average percentage of day-ahead self-supply		Table 3-35 PJM INC and DEC bids by type of parent organization	
demand, bilateral supply demand, and spot-supply demand based		(MW): January through March of 2013 and 2014	92
on parent companies: 2013 through 2014	82	Table 3-36 PJM up-to congestion transactions by type of parent	
Table 3-20 Offer-capping statistics – Energy only: January through		organization (MW): January through March of 2013 and 2014	93
March, 2010 to 2014	82	Table 3-37 PJM import and export transactions by type of parent	
Table 3-21 Offer-capping statistics for energy and reliability: January		organization (MW): January through March of 2013 and 2014	93
through March, 2010 to 2014	83	Table 3-38 PJM virtual offers and bids by top ten locations (MW):	
Table 3-22 Real-time offer-capped unit statistics: January through		January through March of 2013 and 2014	93
March, 2013 and 2014	83	Table 3-39 PJM cleared up-to congestion import bids by top ten source	e
Table 3-23 Numbers of hours when control zones experienced		and sink pairs (MW): January through March of 2013 and 2014	94
congestion for 25 or more hours: January through March, 2009		Table 3-40 PJM cleared up-to congestion export bids by top ten source	7
through 2014	83	and sink pairs (MW): January through March of 2013 and 2014	94
Table 3-24 Three pivotal supplier test details for interface constraints:		Table 3-41 PJM cleared up-to congestion wheel bids by top ten source	<u>,</u>
January through March, 2014	84	and sink pairs (MW): January through March of 2013 and 2014	95
Table 3-25 Summary of three pivotal supplier tests applied for		Table 3-42 PJM cleared up-to congestion internal bids by top ten source	e
interface constraints: January through March, 2014	85	and sink pairs (MW): January through March of 2013 and 2014	95
Table 3-26 Average, real-time marginal unit markup index (By offer		Table 3-43 Number of PJM offered and cleared source and sink pairs:	
price category): January through March 2013 and 2014	86	January 2012 through March 2014	96
Table 3-27 Average day-ahead marginal unit markup index (By offer		Table 3-44 PJM cleared up-to congestion transactions by type (MW):	
price category): January through March of 2013 and 2014	86	January through March of 2013 and 2014	97
Table 3-28 Frequently mitigated units and associated units total		Table 3-45 Distribution of MW for dispatchable unit offer prices:	
months eligible: 2013 and January through March, 2014	87	January through March of 2014	98
Table 3-29 Number of frequently mitigated units and associated		Table 3-46 Distribution of MW for self scheduled offer prices: January	/
units (By month): 2013 and January through March, 2014	88	through March of 2014	99
Table 3-30 Frequently mitigated units at risk of retirement	89	Table 3-47 Markup component of the overall PJM real-time, load-	
Table 3-31 Hourly average number of cleared and submitted INCs,		weighted, average LMP by primary fuel type and unit type:	
DECs by month: January 2013 through March of 2014	90	January through March 2013 and 2014	101
Table 3-32 Hourly average of cleared and submitted up-to congestion		Table 3-48 Monthly markup components of real-time load-weighted	
bids by month: January 2013 through March of 2014	91	LMP (Unadjusted): January through March 2013 and 2014	101
Table 3-33 Hourly average number of cleared and submitted import		Table 3-49 Monthly markup components of real-time load-weighted	
and export transactions by month: January 2013 through March		LMP (Adjusted): January through March, 2013 and 2014	102
of 2014	91	Table 3-50 Average real-time zonal markup component (Unadjusted):	
Table 3-34 Type of day-ahead marginal units: January through		January through March, 2013 and 2014	102
March of 2014	91	Table 3-51 Average real-time zonal markup component (Adjusted):	
		January through March, 2013 and 2014	103

Table 3-52 Average real-time markup component (By price category,		Table 3-68 PJM day-ahead, load-weighted, average LMP (Dollars per	-
unadjusted): January through March, 2013 and 2014	103	MWh): January through March of 2001 through 2014	113
Table 3-53 Average real-time markup component (By price category,		Table 3-69 Components of PJM day-ahead, (unadjusted) annual,	
adjusted): January through March, 2013 and 2014	103	load-weighted, average LMP (Dollars per MWh): January through	h
Table 3-54 Markup component of the annual PJM day-ahead, load-		March of 2013 and 2014	114
weighted, average LMP by primary fuel type and unit type:		Table 3-70 Components of PJM day-ahead, (adjusted) annual, load-	
January through March of 2013 and 2014	104	weighted, average LMP (Dollars per MWh): January through	
Table 3-55 Monthly markup components of day-ahead (Unadjusted),		March of 2013 and 2014	115
load-weighted LMP: January through March of 2013 and 2014	104	Table 3-71 Cleared UTC profitability by source and sink point:	
Table 3-56 Monthly markup components of day-ahead (Adjusted),		January through March of 2013 and 2014	116
load-weighted LMP: January through March of 2013 and 2014	104	Table 3-72 Day-ahead and real-time average LMP (Dollars per MWh)	):
Table 3-57 Day-ahead, average, zonal markup component		January through March of 2013 and 2014	117
(Unadjusted): January through March of 2013 and 2014	105	Table 3-73 Day-ahead and real-time average LMP (Dollars per MWh)	):
Table 3-58 Day-ahead, average, zonal markup component		January through March of 2001 through 2014	117
(Adjusted): January through March of 2013 and 2014	105	Table 3-74 Frequency distribution by hours of PJM real-time LMP	
Table 3-59 Average, day-ahead markup (By LMP category,		minus day-ahead LMP (Dollars per MWh): January through	
unadjusted): January through March of 2013 and 2014	106	March of 2007 through 2014	118
Table 3-60 Average, day-ahead markup (By LMP category, adjusted):		Table 3-76 Description of Emergency Procedures	122
January through March of 2013 and 2014	106	Table 3-77 PJM declared emergency alerts, warnings and actions:	
Table 3-61 PJM real-time, average LMP (Dollars per MWh): January		January through March, 2014	123
through March of 1998 through 2014	108		
Table 3-62 PJM real-time, load-weighted, average LMP (Dollars per			
MWh): January through March of 1998 through 2014	108	SECTION 4 Energy Uplift (Operating Reserves)	137
Table 3-63 PJM real-time annual, fuel-cost adjusted, load-weighted		Table 4-1 Day-ahead and balancing operating reserve credits and	
average LMP (Dollars per MWh): Year-over-year method	110	charges	141
Table 3-64 Change in PJM real-time annual, fuel-cost adjusted, load-		Table 4-2 Reactive services, synchronous condensing and black start	
weighted average LMP (Dollars per MWh) by Fuel-type:		services credits and charges	142
Year-over-year method	110	Table 4-3 Total energy uplift charges: January through March 2013	
Table 3-65 Components of PJM real-time (Unadjusted), annual, load-		and 2014	142
weighted, average LMP: January through March, 2013 and 2014	111	Table 4-4 Energy uplift charges by category: January through	
Table 3-66 Components of PJM real-time (Adjusted), annual, load-		March 2013 and 2014	143
weighted, average LMP: January through March, 2013 and 2014	111	Table 4-5 Monthly energy uplift charges: 2013 and 2014	143
Table 3-67 PJM day-ahead, average LMP (Dollars per MWh): January		Table 4-6 Day-ahead operating reserve charges: January through	
through March of 2001 through 2014	112	March 2013 and 2014	144

Table 4-7 Balancing operating reserve charges: January through		Table 4-24 Day-ahead and real-time generation (GWh): January	
March 2013 and 2014	144	through March 2014	154
Table 4-8 Balancing operating reserve deviation charges: January		Table 4-25 Day-ahead and real-time economic and noneconomic	
through March 2013 and 2014	144	generation from units eligible for operating reserve credits (GWh)	):
Table 4-9 Additional energy uplift charges: January through March		January through March 2014	154
2013 and 2014	145	Table 4-26 Day-ahead and real-time generation receiving operating	
Table 4-10 Regional balancing charges allocation: January through		reserve credits (GWh): January through March 2014	154
March 2013	145	Table 4-27 Day-ahead generation scheduled as must run by PJM	
Table 4-11 Regional balancing charges allocation: January through		(GWh): 2013 and 2014	155
March 2014	145	Table 4-28 Day-ahead generation scheduled as must run by PJM by	
Table 4-12 Operating reserve rates (\$/MWh): January through		category (GWh): 2014	156
March 2013 and 2014	148	Table 4-29 Geography of regional charges and credits: January	
Table 4-13 Operating reserve rates statistics (\$/MWh): January		through March 2014	157
through March 2014	148	Table 4-30 Geography of reactive services charges: January through	
Table 4-14 Local voltage support rates: January through March		March 2014	158
2013 and 2014	149	Table 4-31 Monthly lost opportunity cost credits: 2013 and 2014	159
Table 4-15 Balancing operating reserve determinants (MWh):		Table 4-32 Day-ahead generation from combustion turbines and	
January through March 2013 and 2014	150	diesels (GWh): 2013 and 2014	159
Table 4-16 Deviations by transaction type: January through March		Table 4-33 Lost opportunity cost credits paid to combustion turbines	
2014	150	and diesels by scenario: 2013 and 2014	160
Table 4-17 Energy uplift credits by category: January through		Table 4-34 Day-ahead generation (GWh) from combustion turbines	
March 2013 and 2014	151	and diesels receiving lost opportunity cost credits by value:	
Table 4-18 Energy uplift credits by unit type: January through		2013 and 2014	161
March 2013 and 2014	152	Table 4-35 Impact on energy market lost opportunity cost credits of	
Table 4-19 Energy uplift credits by unit type: January through		rule changes: January through March 2014	166
March 2014	152	Table 4-36 Current energy uplift allocation	169
Table 4-20 Top 10 energy uplift credits units (By percent of total		Table 4-37 MMU energy uplift allocation proposal	169
system): January through March 2013 and 2014	153	Table 4-38 Current and proposed average energy uplift rate by	
Table 4-21 Top 10 units and organizations energy uplift credits:		transaction: 2013 and January through March 2014	170
January through March 2014	153		
Table 4-22 Identification of balancing operating reserve credits			
received by the top 10 units by category and region: January			
through March 2014	153		
Table 4-23 Daily energy uplift credits HHI: January through			
March 2014	153		

SECTION 5 Capacity Market	175	Table 5-21 Contributions to Economic Outages: January through	
Table 5-1 The Capacity Market results were competitive	175	March 2014	200
Table 5-2 RPM related MMU reports, 2013 through March, 2014	179	Table 5-22 PJM EFORd, XEFORd and EFORp data by unit type:	200
Table 5-3 PJM installed capacity (By fuel source): January 1,		January through March 2014	200
January 31, February 28, and March 31, 2014	180		
Table 5-4 RSI results: 2014/2015 through 2016/2017 RPM Auctions	181	SECTION 6 Demand Response	203
Table 5-5 RPM load management statistics by LDA: June 1, 2012 to		•	
June 1, 2016	184	Table 6-1 Overview of demand response programs	205
Table 5-6 RPM load management cleared capacity and ILR:		Table 6-2 Economic program registrations on the last day of the	200
2007/2008 through 2016/2017	185	month: 2011 through March, 2014	206
Table 5-7 RPM load management statistics: June 1, 2007 to		Table 6-3 Maximum economic MW dispatched by registration per	207
June 1, 2016,	185	month: 2011 through March, 2014  Table 6-4 Credits paid to the PJM economic program participants	207
Table 5-8 ACR statistics: 2014/2015 RPM Auctions	186	excluding incentive credits: January through March, 2010	
Table 5-9 Capacity prices: 2007/2008 through 2016/2017 RPM		through 2014	207
Auctions	187	Table 6-5 PJM Economic program participation by zone: January	207
Table 5-10 RPM revenue by type: 2007/2008 through 2016/2017	188	through March, 2013 and 2014	208
Table 5-11 RPM revenue by calendar year: 2007 through 2017	188	Table 6-6 Settlements submitted by year in the economic program:	200
Table 5-12 RPM cost to load: 2013/2014 through 2016/2017 RPM		2008 through March, 2014	208
Auctions	190	Table 6-7 Distinct participants and CSPs submitting settlements in	200
Table 5-13 PJM capacity factor (By unit type (GWh)): January		the Economic Program by year: 2009 through March, 2014	209
through March of 2013 and 2014	191	Table 6-8 Hourly frequency distribution of economic program MWh	203
Table 5-14 EAF by unit type: January through March, 2007 through	100	reductions and credits: January through March, 2013 and 2014	209
2014	193	Table 6-9 Frequency distribution of economic program zonal, load-	203
Table 5-15 EMOF by unit type: January through March, 2007 through		weighted, average LMP (By hours): January through March, 2013	3
2014 Table F. 16 EPOE by writ tymes language through March 2007 through	193	and 2014	209
Table 5-16 EPOF by unit type: January through March, 2007 through 2014		Table 6-10 Zonal monthly capacity credits: January through March,	
	193	2014	210
Table 5-17 EFOF by unit type: January through March, 2007 through 2014	193	Table 6-11 LDA Energy efficiency resources by MW:	
Table 5-18 PJM EFORd data for different unit types: January through		2012/2013 and 2013/2014 Delivery Year	210
March, 2007 through March 2014	194	Table 6-12 Reduction MW by each demand response method:	
Table 5-19 OMC Outages: January through March 2014	196	2013/2014 Delivery Year	211
Table 5-20 Contribution to EFOF by unit type by cause: January	150	Table 6-13 On-site generation fuel type by MW: 2013/2014	
through March 2014	199	Delivery Year	211

Table 6-14 Demand response cleared MW UCAP for PJM: 2011/2012		SECTION 7 Net Revenue	223
through 2013/2014 Delivery Year	211	Table 7-1 Average zonal operating costs: January through March, 2014	226
Table 6-15 PJM declared load management events: January through		Table 7-2 Run hours: January through March, 2013 and 2014	227
March, 2014	212	Table 7-3 Energy Market net revenue for a new entrant gas-fired CT	
Table 6-16 Demand response event performance: January 7, 2014		under economic dispatch (Dollars per installed MW-year):	
(Event 1)	213	January through March, 2013 and 2014	227
Table 6-17 Demand response event performance: January 7, 2014		Table 7-4 PJM Energy Market net revenue for a new entrant gas-fired	
(Event 2)	214	CC under economic dispatch (Dollars per installed MW-year):	
Table 6-18 Demand response event performance: January 8, 2014	214	January through March, 2013 and 2014	228
Table 6-19 Demand response event performance: January 22, 2014	215	Table 7-5 PJM Energy Market net revenue for a new entrant CP	
Table 6-20 Demand response event performance: January 23, 2014		(Dollars per installed MW-year): January through March, 2013	
(Event 1)	215	and 2014	228
Table 6-21 Demand response event performance: January 23, 2014		Table 7-6 PJM Energy Market net revenue for a new entrant DS	
(Event 2)	215	(Dollars per installed MW-year): January through March, 2013	
Table 6-22 Demand response event performance: January 24, 2014	216	and 2014	229
Table 6-23 Load management event performance: January through		Table 7-7 PJM Energy Market net revenue for a new entrant nuclear	
March, 2014 Aggregated	216	plant (Dollars per installed MW-year): January through March,	
Table 6-24 Distribution of participant event days and nominated		2013 and 2014	229
MW across ranges of performance levels across the events:		Table 7-8 Energy Market net revenue for a wind installation	
January through March; 2014	217	(Dollars per installed MW-year): January through March, 2013	
Table 6-25 Non-reporting locations and nominated ICAP on 2014		and 2014	230
event days	218	Table 7-9 PSEG Energy Market net revenue for a solar installation	
Table 6-26 Distribution of registrations and associated MW in the		(Dollars per installed MW-year): January through March, 2013	
emergency full option across ranges of minimum dispatch prices		and 2014	230
effective for the 2013/2014 Delivery Year	219		
Table 6-27 Energy reduction MWh and average real-time LMP during			
demand response event days: 2014	220	SECTION 8 Environmental and Renewable Energy	
Table 6-28 Emergency credits by event: 2014	221	Regulations	231
Table 6-29 Penalty charges per zone: June through March 2012/2013		Table 8-1 HEDD maximum NOx emission rates	237
and 2013/2014 Delivery Years	222	Table 8-2 RGGI CO2 allowance auction prices and quantities in	231
		·	238
		short tons: 2009–2011 and 2012–2014 Compliance Periods Table 8–3 RGGl CO2 allowance auction prices and quantities in metric	
		tonnes: 2009–2011 and 2012–2014 Compliance Periods	
		•	239
		Table 8-4 Renewable standards of PJM jurisdictions to 2024	240

Table 8-5 Pennsylvania weighted average AEC price and AEC price		Table 9-4 Real-time scheduled net interchange volume by interface	
range for 2010 to 2014 Delivery Years	240	pricing point (GWh): January through March, 2014	256
Table 8-6 Solar renewable standards of PJM jurisdictions 2014 to 2024	241	Table 9-5 Real-time scheduled gross import volume by interface	
Table 8-7 Additional renewable standards of PJM jurisdictions 2014		pricing point (GWh): January through March, 2014	257
to 2024	241	Table 9-6 Real-time scheduled gross export volume by interface	
Table 8-8 Renewable alternative compliance payments in PJM		pricing point (GWh): January through March, 2014	257
jurisdictions: As of March 31, 2014	242	Table 9-7 Day-Ahead scheduled net interchange volume by interface	
Table 8-9 Renewable generation by jurisdiction and renewable		(GWh): January through March, 2014	258
resource type (GWh): January through March 2014	242	Table 9-8 Day-Ahead scheduled gross import volume by interface	
Table 8-10 PJM renewable capacity by jurisdiction (MW), on		(GWh): January through March, 2014	259
March 31, 2014	243	Table 9-9 Day-Ahead scheduled gross export volume by interface	
Table 8-11 Renewable capacity by jurisdiction, non-PJM units		(GWh): January through March, 2014	259
registered in GATS (MW) on March 31, 2014	243	Table 9-10 Day-ahead scheduled net interchange volume by interface	
Table 8-12 SO <sub>2</sub> emission controls (FGD) by fuel type (MW), as of		pricing point (GWh): January through March, 2014	261
March 31, 2014	244	Table 9-11 Up-to congestion scheduled net interchange volume by	
Table 8-13 NO <sub>x</sub> emission controls by fuel type (MW), as of		interface pricing point (GWh): January through March, 2014	261
March 31, 2014	244	Table 9-12 Day-ahead scheduled gross import volume by interface	
Table 8-14 Particulate emission controls by fuel type (MW), as of		pricing point (GWh): January through March, 2014	262
March 31, 2014	244	Table 9-13 Up-to congestion scheduled gross import volume by	
Table 8-15 CO <sub>2</sub> , SO <sub>2</sub> and NO <sub>3</sub> emissions by month (metric tons), by		interface pricing point (GWh): January through March, 2014	262
PJM units, January through March, 2014	245	Table 9-14 Day-ahead scheduled gross export volume by interface	
Table 8-16 Capacity factor of wind units in PJM: January through		pricing point (GWh): January through March, 2014	263
March 2014	245	Table 9-15 Up-to congestion scheduled gross export volume by	
Table 8-17 Capacity factor of wind units in PJM by month, 2013		interface pricing point (GWh): January through March, 2014	263
and January through March 2014	246	Table 9-16 Active interfaces: January through March, 2014	264
		Table 9-17 Active pricing points: January through March, 2014	264
		Table 9-18 Net scheduled and actual PJM flows by interface (GWh):	
SECTION 9 Interchange Transactions	249	January through March, 2014	265
Table 9-1 Real-time scheduled net interchange volume by interface		Table 9-19 Net scheduled and actual PJM flows by interface pricing	
(GWh): January through March, 2014	254	point (GWh): January through March, 2014	267
Table 9-2 Real-time scheduled gross import volume by interface		Table 9-20 Net scheduled and actual PJM flows by interface pricing	
(GWh): January through March, 2014	254	point (GWh) (Adjusted for IMO Scheduled Interfaces): January	
Table 9-3 Real-time scheduled gross export volume by interface		through March, 2014	267
(GWh): January through March, 2014	255	Table 9-21 Net scheduled and actual PJM flows by interface and	
		interface pricing point (GWh): January through March, 2014	268

Table 9-22 Net scheduled and actual PJM flows by interface pricing		Table 10-7 Impact on PJM Regulation Market of currently regulating	
point and interface (GWh): January through March, 2014	269	units scheduled to retire through 2015	301
Table 9-23 Distribution of economic and uneconomic hourly flows		Table 10-8 PJM Regulation Market required MW and ratio of eligible	
between PJM and MISO: January through March, 2014	271	supply to requirement: January through March, 2013 and 2014	302
Table 9-24 Distribution of economic and uneconomic hourly flows		Table 10-9 PJM cleared regulation HHI: January through March	
between PJM and NYISO: January through March, 2014	273	2013 and 2014	303
Table 9-25 Real-time average hourly LMP comparison for Duke, PEC		Table 10-10 Regulation market monthly three pivotal supplier results:	
and NCMPA: January through March, 2014	280	January through March 2012 through 2014	304
Table 9-26 Day-ahead average hourly LMP comparison for Duke, PEC		Table 10-11 Regulation sources: spot market, self-scheduled, bilateral	
and NCMPA: January through March, 2014	280	purchases: January through March 2013 and 2014	305
Table 9-27 PJM MISO, and NYISO TLR procedures: January, 2010		Table 10-12 Regulation sources by year: January through	
through March, 2014	282	March, 2010 through 2014	305
Table 9-28 Number of TLRs by TLR level by reliability coordinator:		Table 10-13 PJM Regulation Market monthly weighted average	
January through March, 2014	282	market-clearing price, marginal unit opportunity cost and offer	
Table 9-29 Monthly volume of cleared and submitted up-to		price (Dollars per MW): 2014	306
congestion bids: January, 2009 through March, 2014	284	Table 10-14 Total regulation charges: January through March,	
Table 9-30 ITSCED/real-time LMP - PJM/NYIS interface price		2013 and 2014	306
comparison (all intervals): 2013	287	Table 10-15 Components of regulation cost: 2014	306
Table 9-31 ITSCED/real-time LMP - PJM/NYIS interface price		Table 10-16 Comparison of average price and cost for PJM	
comparison (by interval): 2013	287	Regulation, January through March, 2008 through 2014	307
Table 9-32 Monthly uncollected congestion charges: January, 2010		Table 10-17 Tier 2 Synchronized Reserve Markets required MW, RTO	
through March, 2014	288	Zone and Mid-Atlantic Dominion Subzone	311
		Table 10-18 Exceptions to RTO Zone and MAD Subzone Synchronized	
CEOTION AS A WAY OF A A A A		Reserve requirement: January through March 2014	312
SECTION 10 Ancillary Service Markets	291	Table 10-19 Three Pivotal Supplier Test Results for the RTO Zone	
Table 10-1 The Regulation Market results were competitive	291	and MAD Subzone: January through March, 2014	313
Table 10-2 The Synchronized Reserve Markets results were competitive	291	Table 10-20 RTO Zone, Mid-Atlantic Dominion Subzone, and Full RTO	1
Table 10-3 The Day-Ahead Scheduling Reserve Market results were		credits, and MWs: January through March 2014	316
competitive	292	Table 10-21 RTO Zone, Mid-Atlantic Dominion Subzone, and Full RTO	
Table 10-4 History of ancillary services costs per MWh of Load:		Weighted SRMCP, Tier 2 Cost, and Synchronized Reserve Cost	316
January through March, 2003 through 2014	296	Table 10-22 Synchronized reserve events greater than 10 minutes,	
Table 10-5 PJM regulation capability, daily offer and hourly eligible:		Mid-Atlantic Dominion Tier 2 Response Compliance January	
January through March 2014	300	through March 2014	319
Table 10-6 PJM regulation provided by coal units	300	Table 10-23 Spinning events: 2011 through 2014	320

Table 10-24 PJM Day-Ahead Scheduling Reserve Market MW and		Table 11-10 Total PJM congestion costs by accounting category by	
clearing prices: January 2012 Through March 2014	324	market (Dollars (Millions)): January through March of 2008	
Table 10-25 Black start revenue requirement charges: January		through 2014	339
through March, 2009 through 2014	326	Table 11-11 Monthly PJM congestion costs by market (Dollars	
Table 10-26 Black start zonal charges for network transmission use:		(Millions)): January through March of 2013 and 2014	339
January through March, 2013 and 2014	327	Table 11-12 Congestion summary (By facility type): January through	
Table 10-27 Revenue Requirement Estimate: Delivery Years		March of 2014	341
2014-2015 through 2016-2017	328	Table 11-13 Congestion summary (By facility type): January through	
Table 10-28 NERC CIP Costs: January through March 2014	328	March of 2013	341
Table 10-29 Reactive zonal charges for network transmission use:		Table 11-14 Congestion event hours (Day-Ahead against Real-Time):	
January through March 2013 and 2014	329	January through March of 2013 and 2014	342
		Table 11-15 Congestion event hours (Real-Time against Day-Ahead):	
CEOTION 44 O	224	January through March of 2013 and 2014	342
SECTION 11 Congestion and Marginal Losses	331	Table 11-16 Congestion summary (By facility voltage): January	
Table 11-1 PJM real-time, load-weighted average LMP components		through March of 2014	343
(Dollars per MWh): January through March of 2009 through 2014	333	Table 11-17 Congestion summary (By facility voltage): January	
Table 11-2 PJM day-ahead, load-weighted average LMP components		through March of 2013	343
(Dollars per MWh): January through March of 2009 through 2014	334	Table 11-18 Top 25 constraints with frequent occurrence: January	
Table 11-3 Zonal and PJM real-time, load-weighted average LMP		through March of 2013 and 2014	344
components (Dollars per MWh): January through March of 2013		Table 11-19 Top 25 constraints with largest year-to-year change in	
and 2014	335	occurrence: January through March of 2013 and 2014	345
Table 11-4 Zonal and PJM day-ahead, load-weighted average LMP		Table 11-20 Top 25 constraints affecting PJM congestion costs (By	
components (Dollars per MWh): January through March of 2013		facility): January through March of 2014	346
and 2014	336	Table 11-21 Top 25 constraints affecting PJM congestion costs (By	
Table 11-5 Hub real-time, load-weighted average LMP components		facility): January through March of 2013	347
(Dollars per MWh): January through March of 2013 and 2014	337	Table 11-22 Top 20 congestion cost impacts from MISO flowgates	
Table 11-6 Hub day-ahead, load-weighted average LMP components		affecting PJM dispatch (By facility): January through	
(Dollars per MWh): January through March of 2013 and 2014	337	March of 2014	349
Table 11-7 Total PJM costs by component (Dollars (Millions)):		Table 11-23 Top 20 congestion cost impacts from MISO flowgates	
January through March of 2009 through 2014	338	affecting PJM dispatch (By facility): January through	
Table 11-8 Total PJM congestion (Dollars (Millions)): January		March of 2013	350
through March of 2008 through 2014	338	Table 11-24 Top two congestion cost impacts from NYISO flowgates	
Table 11-9 Total PJM congestion costs by accounting category (Dollars		affecting PJM dispatch (By facility): January through March of	
(Millions)): January through March of 2008 through 2014	339	2014	351

Table 11-25 Top two congestion cost impacts from NYISO flowgates		SECTION 12 Generation and Transmission Planning	361
affecting PJM dispatch (By facility): January through March of 2013	351	Table 12-1 Year-to-year capacity additions from PJM generation queue: Calendar years 2000 through 2014	363
Table 11-26 Regional constraints summary (By facility): January through March of 2014	352	Table 12-2 Queue comparison by expected completion year (MW): March 31, 2014 vs. December 31, 2013	363
Table 11-27 Regional constraints summary (By facility): January through March of 2013	352	Table 12-3 Change in project status (MW): December 31, 2013 vs.  March 31, 2014	364
Table 11-28 Congestion cost by type of participant: January through March of 2014	353	Table 12-4 Capacity in PJM queues (MW): At March 31, 2014 Table 12-5 Queue capacity by control zone and LDA (MW) at	364
Table 11–29 Congestion cost by type of participant: January through March of 2013	353	March 31, 2014 Table 12-6 Summary of PJM unit retirements (MW): 2011 through	365
Table 11-30 Total PJM costs by loss component (Dollars (Millions)):  January through March of 2009 through 2014	354	2019 Table 12-7 Planned deactivations of PJM units, as of March 31, 2014	366 367
Table 11–31 Total PJM marginal loss costs by accounting category (Dollars (Millions)): January through March of 2009 through 2014	354	Table 12-9 Unit deactivations between January 1, 2014 and	367
Table 11–32 Total PJM marginal loss costs by accounting category by market (Dollars (Millions)): January through March of 2009	255	March 31, 2014 Table 12–10 Existing PJM capacity: At March 31, 2014 (By zone and	368
through 2014 Table 11-33 Monthly marginal loss costs by market (Dollars (Millions)):	355	unit type (MW)) Table 12-11 PJM capacity (MW) by age (years): at March 31, 2014	368 369
January through March of 2013 and 2014  Table 11-34 Marginal loss credits (Dollars (Millions)): January	355	Table 12-12 Comparison of generators 40 years and older with slated	
through March of 2009 through 2014	356	capacity additions (MW) through 2024, as of March 31, 2014 Table 12-13 PJM generation planning process	370 371
Table 11-35 Total PJM costs by energy component (Dollars (Millions)): January through March of 2009 through 2014	357	Table 12-14 PJM Commercial probabilities  Table 12-15 Milestone due at time of withdrawal	371 372
Table 11-36 Total PJM energy costs by accounting category (Dollars (Millions)): January through March of 2009		Table 12-16 Average project queue times (days) at March 31, 2014	372
through 2014	357	Table 12-17 PJM generation planning summary: at March 31, 2014 Table 12-18 Days to complete transmission studies	372 372
Table 11-37 Total PJM energy costs by market category (Dollars (Millions)): January through March of 2009 through 2014 Table 11-38 Monthly energy costs by market type (Dollars (Millions)):	358	Table 12-19 Study milestone delays by transmission owner and milestone	373
January through March of 2013 and 2014	358		

SECTION 13 Financial Transmission and Auction	
Revenue Rights	375
Table 13-1 The FTR Auction Markets results were competitive	375
Table 13-2 Monthly Balance of Planning Period FTR Auction patterns	
of ownership by FTR direction: January through March 2014	382
Table 13–3 Daily FTR net position ownership by FTR direction:	
January through March 2014	382
Table 13-4 Monthly Balance of Planning Period FTR Auction market	
volume: January through March 2014	385
Table 13-5 Monthly Balance of Planning Period FTR Auction buy-bid,	
bid and cleared volume (MW per period): January through	
March 2014	386
Table 13-6 Secondary bilateral FTR market volume: Planning	
periods 2012 to 2013 and 2013 to 2014	387
Table 13-7 Monthly Balance of Planning Period FTR Auction cleared,	
weighted-average, buy-bid price per period (Dollars per MW):	
January through March 2014	388
Table 13-8 FTR profits by organization type and FTR direction:	
January through March 2014	388
Table 13-9 Monthly FTR profits by organization type: January	
through March 2014	388
Table 13-10 Monthly Balance of Planning Period FTR Auction	
revenue: January through March 2014	389
Table 13-11 Total annual PJM FTR revenue detail (Dollars (Millions)):	
Planning periods 2012 to 2013 and 2013 to 2014	393
Table 13-12 Unallocated congestion charges: Planning period 2012	
to 2013 to 2013 and 2014	393
Table 13-13 Monthly FTR accounting summary (Dollars (Millions)):	
Planning period 2012 to 2013 and 2013 to 2014	394
Table 13-14 PJM reported FTR payout ratio by planning period	395
Table 13-15 End of planning period FTR uplift charge example	396
Table 13-16 PJM Reported and Actual Monthly Payout Ratios:	
Planning period 2013 to 2014	396

Table 13-17 Example of FTR payouts from portfolio netting and	
without portfolio netting	398
Table 13-18 Monthly positive and negative target allocations and	
payout ratios with and without hourly netting: Planning period	
2012 to 2013 and 2013 to 2014	398
Table 13-19 Example implementation of counter flow adjustment	
method	399
Table 13-20 Counter flow FTR payout ratio adjustment impacts	400
Table 13–21 Top 10 principal binding transmission constraints limiting	
the Annual ARR Allocation: Planning period 2013 to 2014	403
Table 13-22 ARRs and ARR revenue automatically reassigned for	
network load changes by control zone: June 1, 2012, through	
March 31, 2014	404
Table 13-23 Residual ARR allocation volume and target allocation	404
Table 13-24 Annual ARR Allocation volume: planning periods 2012	
to 2013 and 2013 to 2014	405
Table 13-25 Constraints with capacity increases due to Stage 1A	
infeasibility for the 2013 to 2014 ARR Allocation	406
Table 13-26 Projected ARR revenue adequacy (Dollars (Millions)):	
Planning periods 2012 to 2013 and 2013 to 2014	406
Table 13-27 ARR and self-scheduled FTR congestion offset	
(in millions) by control zone: 2013 to 2014 planning period	
through March 31, 2014	408
Table 13-28 ARR and FTR congestion offset (in millions) by control	
zone: 2013 to 2014 planning period through March 31, 2014	409
Table 13-29 ARR and FTR congestion hedging (in millions):	
Planning periods 2012 to 2013 and 2013 to 2014	409