

TABLE OF CONTENTS

PREFACE	1
SECTION 1 INTRODUCTION	1
2012 In Review	1
PJM Market Background	1
Conclusions	2
Role of MMU	6
Reporting	6
Monitoring	7
Market Design	8
Prioritized Summary Recommendations	8
Detailed Recommendations	10
From Section 2, "Energy Market":	10
From Section 3, "Operating Reserve":	10
From Section 4, "Capacity":	11
From Section 5, "Demand Response":	12
From Section 6, "Net Revenue":	12
From Section 7, "Environmental and Renewables":	13
From Section 8, "Interchange Transactions":	13
From Section 9, "Ancillary Services":	13
From Section 10, "Congestion and Marginal Losses":	13
From Section 11, "Planning":	13
From Section 12, "FTRs and ARRs":	13
Total Price of Wholesale Power	14
Components of Total Price	14
Section Overviews	16
Overview: Section 2, "Energy Market"	16
Overview: Section 3, "Operating Reserve"	19
Overview: Section 4, "Capacity Market"	22
Overview: Section 5, "Demand Response"	26
Overview: Section 6, "Net Revenue"	28
Overview: Section 7, "Environmental and Renewables"	30
Overview: Section 8, "Interchange Transactions"	31
Overview: Section 9, "Ancillary Services"	35
Overview: Section 10, "Congestion and Marginal Losses"	39
Overview: Section 11, "Planning"	42
Overview: Section 12, "FTR and ARRs"	44

SECTION 2 ENERGY MARKET	49
Overview	50
Market Structure	50
Market Performance: Markup, Load, Generation and LMP	50
Scarcity	52
Conclusion	52
Market Structure	53
Supply	53
Demand	56
Market Concentration	57
Local Market Structure and Offer Capping	58
Local Market Structure	60
Ownership of Marginal Resources	61
Type of Marginal Resources	61
Market Conduct: Markup	62
Real-Time Mark Up Conduct	62
Day-Ahead Mark Up Conduct	63
Market Performance	63
Markup	63
Real-Time Markup	64
Day-Ahead Markup	66
Market Performance: Load and LMP	69
Load	69
Locational Marginal Price (LMP)	76
Load and Spot Market	92
Scarcity and Scarcity Pricing	93
Designation of Maximum Emergency MW	93
2012 Results: High-Load Days	95
SECTION 3 OPERATING RESERVE	97
Overview	97
Operating Reserve Results	97
Characteristics of Credits	97
Geography of Balancing Charges and Credits	97
Load Response Resource Operating Reserves	97
Operating Reserve Issues	98
Conclusion	98
Description of Operating Reserves	99
Credits and Charges Categories	100
Balancing Operating Reserve Cost Allocation	101
Operating Reserve Results	103
Operating Reserve Charges	103
Operating Reserve Rates	106

Operating Reserve Determinants	108
Operating Reserve Credits	109
Characteristics of Credits	109
Types of Units	109
Economic and Noneconomic Generation	111
Geography of Charges and Credits	112
Load Response Resource Operating Reserves	115
Operating Reserve Issues	115
Concentration of Operating Reserve Credits	115
Day-Ahead Unit Commitment for Reliability	117
Lost Opportunity Cost Credits	119
Black Start and Voltage Support Units	125
Con Edison – PSEG Wheeling Contracts Support	125
Reactive Service Credits and Operating Reserve Credits	126
Up-to Congestion Transactions	126
SECTION 4 CAPACITY MARKET	129
Overview	129
RPM Capacity Market	129
Generator Performance	132
Conclusion	132
Installed Capacity	135
RPM Capacity Market	135
Market Structure	136
Market Conduct	149
Market Performance	157
Generator Performance	160
Capacity Factor	161
Generator Performance Factors	161
Generator Forced Outage Rates	162
SECTION 5 DEMAND-SIDE RESPONSE (DSR)	169
Overview	169
Conclusions	169
PJM Demand Side Programs	171
Participation in Demand Side Programs	171
Economic Program	172
Load Management Program	177
Measurement and Verification	186
SECTION 6 NET REVENUE	189
Overview	189
Net Revenue	189
Conclusion	189

Net Revenue	190
Theoretical Energy Market Net Revenue	191
Capacity Market Net Revenue	192
New Entrant Combustion Turbine	193
New Entrant Combined Cycle	194
New Entrant Coal Plant	194
New Entrant Integrated Gasification Combined Cycle	195
New Entrant Nuclear Plant	195
New Entrant Wind Installation	195
New Entrant Solar Installation	196
Net Revenue Adequacy	196
Actual Net Revenue	201
Environmental Rules	206
SECTION 7 ENVIRONMENTAL AND RENEWABLE ENERGY REGULATIONS	207
Overview	207
Federal Environmental Regulation	207
State Environmental Regulation	208
Emissions Controls in PJM Markets	208
State Renewable Portfolio Standards	208
Conclusion	208
Federal Environmental Regulation	209
Control of Mercury and Other Hazardous Air Pollutants	209
Control of NO _x and SO ₂ Emissions Allowances	210
Emission Standards for Reciprocating Internal Combustion Engines	210
Regulation of Greenhouse Gas Emissions	211
Federal Regulation of Environmental Impacts on Water	212
State Environmental Regulation	212
New Jersey High Electric Demand Day (HEDD) Rules	212
State Regulation of Greenhouse Gas Emissions	213
Renewable Portfolio Standards	214
Emissions Controlled Capacity and Renewables in PJM Markets	218
Emission Controlled Capacity in the PJM Region	218
Wind Units	219
Solar Units	222
SECTION 8 INTERCHANGE TRANSACTIONS	223
Overview	223
Interchange Transaction Activity	223
Interactions with Bordering Areas	224
Conclusion	225
Interchange Transaction Activity	226
Aggregate Imports and Exports	226

Real-Time Interface Imports and Exports	227
Real-Time Interface Pricing Point Imports and Exports	230
Day-Ahead Interface Imports and Exports	234
Day-Ahead Interface Pricing Point Imports and Exports	237
Loop Flows	242
PJM and MISO Interface Prices	248
PJM and NYISO Interface Prices	249
Summary of Interface Prices between PJM and Organized Markets	251
Neptune Underwater Transmission Line to Long Island, New York	251
Linden Variable Frequency Transformer (VFT) Facility	252
Hudson Direct Current (DC) Merchant Transmission Line	252
Operating Agreements with Bordering Areas	252
PJM and MISO Joint Operating Agreement	253
PJM and New York Independent System Operator Joint Operating Agreement (JOA)	254
PJM, MISO and TVA Joint Reliability Coordination Agreement (JRCA)	254
PJM and Progress Energy Carolinas, Inc. Joint Operating Agreement	255
PJM and VACAR South Reliability Coordination Agreement	255
Interface Pricing Agreements with Individual Balancing Authorities	255
Other Agreements/Protocols with Bordering Areas	255
Interchange Transaction Issues	257
PJM Transmission Loading Relief Procedures (TLRs)	257
Up-To Congestion	258
Sham Scheduling	262
Elimination of Sources and Sinks	262
Willing to Pay Congestion and Not Willing to Pay Congestion	262
Spot Imports	263
Real-Time Dispatchable Transactions	263
NYISO Interface Pricing Error	264
SECTION 9 ANCILLARY SERVICE MARKETS	265
Overview	267
Regulation Market	267
Synchronized Reserve Market	268
DASR	269
Black Start Service	269
Ancillary services costs per MW of load: 2001 - 2012	269
Conclusion	270
Regulation Market	271
Regulation Market Changes for Performance Based Regulation	271
Market Structure	273
Market Conduct	276
Market Performance	277
Primary Reserve	278

Synchronized Reserve Market	281
Market Structure	281
Market Conduct	284
Market Performance	285
Non-Synchronized Reserve Market	288
Day Ahead Scheduling Reserve (DASR)	289
Market Structure	289
Market Conduct	290
Market Performance	290
Black Start Service	291
SECTION 10 CONGESTION AND MARGINAL LOSSES	293
Overview	293
Marginal Loss Cost	293
Congestion Cost	294
Conclusion	296
Locational Marginal Price (LMP)	297
Components	297
Zonal Components	299
Energy Costs	300
Energy Accounting	300
Total Energy Costs	300
Marginal Losses	302
Marginal Loss Accounting	302
Total Marginal Loss Costs	302
Congestion	304
Congestion Accounting	304
Total Congestion	306
Congested Facilities	307
Congestion by Facility Type and Voltage	308
Constraint Duration	311
Constraint Costs	312
Congestion-Event Summary for MISO Flowgates	314
Congestion-Event Summary for the 500 kV System	315
Congestion Costs by Physical and Financial Participants	316
SECTION 11 GENERATION AND TRANSMISSION PLANNING	317
Overview	317
Planned Generation and Retirements	317
Generation and Transmission Interconnection Planning Process	317
Key Backbone Facilities	317
Economic Planning Process	317
Conclusion	318
Planned Generation and Retirements	318

Planned Generation Additions	318
Planned Deactivations	324
Actual Generation Deactivations in 2012	325
Updates on Key Backbone Facilities	327
Transmission Planning Rules	328
Competitive Grid Development	328
SECTION 12 FINANCIAL TRANSMISSION AND AUCTION REVENUE RIGHTS	331
Overview	332
Financial Transmission Rights	332
Auction Revenue Rights	334
Conclusion	335
Financial Transmission Rights	336
Market Structure	337
Market Behavior	342
Market Performance	343
Revenue Adequacy Issues and Solutions	360
Auction Revenue Rights	363
Market Structure	364
Market Performance	368
APPENDIX A PJM GEOGRAPHY	373
APPENDIX B PJM MARKET MILESTONES	377
APPENDIX C ENERGY MARKET	379
Load	379
Frequency Distribution of Load	379
Off-Peak and On-Peak Load	379
Locational Marginal Price (LMP)	380
Real-Time LMP	381
Day-Ahead and Real-Time LMP	383
LMP by Zone and by Jurisdiction	387
Offer-Capped Units	390
APPENDIX D LOCAL ENERGY MARKET STRUCTURE: TPS RESULTS	395
AP Control Zone Results	395
ATSI Control Zone Results	396
ComEd Control Zone Results	397
DEOK Control Zone Results	398
DLCO Control Zone Results	399
Dominion Control Zone Results	399
DPL Control Zone Results	400
PECO Control Zone Results	401
Pepco Control Zone Results	401

PSEG Control Zone Results	402
APPENDIX E INTERCHANGE TRANSACTIONS	403
Submitting Transactions into PJM	403
Real-Time Market	403
Curtailment of Transactions	405
Transmission Loading Relief (TLR)	406
NYISO Issues	408
Consolidated Edison Company (Con Edison) and Public Service Electric and Gas Company (PSE&G) Wheeling Contracts	409
Initial Implementation of the FERC Protocol	411
APPENDIX F ANCILLARY SERVICE MARKETS	415
Area Control Error (ACE)	415
Control Performance Standard 1 (CPS1) and Balancing Authority ACE Limit (BAAL)	415
Regulation Market Changes for Performance Based Regulation	416
Synchronized Reserve Market Clearing	420
APPENDIX G CONGESTION AND MARGINAL LOSSES	421
LMP Components Real-Time and Day-Ahead	421
Congestion Costs	423
Zonal Congestion Costs	423
Details of Regional and Zonal Congestion	425
Marginal Losses	445
Zonal Marginal Loss Costs	445
Energy	447
Zonal Energy Costs	447
APPENDIX H FTR VOLUMES	449
APPENDIX I GLOSSARY	451
APPENDIX J LIST OF ACRONYMS	459

TABLES

SECTION 1 INTRODUCTION	1
Table 1-1 The Energy Market results were competitive	3
Table 1-2 The Capacity Market results were competitive	4
Table 1-3 The Regulation Market results were not competitive for the first three quarters and were indeterminate for the fourth quarter	5
Table 1-4 The Synchronized Reserve Markets results were competitive	5
Table 1-5 The Day-Ahead Scheduling Reserve Market results were competitive	6
Table 1-6 The FTR Auction Markets results were competitive	6
Table 1-7 Prioritized summary recommendations	9
Table 1-8 Total price per MWh by category and total revenues by category: 2011 and 2012	15
Table 1-9 Total price per MWh by category: Calendar years 2001 through 2012	15
Table 1-10 Percentage of total price per MWh by category: Calendar years 2001 through 2012	16
SECTION 2 ENERGY MARKET	49
Table 2-1 The Energy Market results were competitive	49
Table 2-2 PJM generation (By fuel source (GWh)): 2011 and 2012	54
Table 2-3 PJM Generation (By fuel source (GWh)): 2011 and 2012; excluding ATSI and DEOK zones	54
Table 2-4 Monthly PJM Generation (By fuel source (GWh)): 2012	55
Table 2-5 Distribution of MW for dispatchable unit offer prices: 2012	55
Table 2-6 Distribution of MW for self-scheduled unit offer prices: 2012	56
Table 2-7 Actual PJM footprint peak loads: 1999 to 2012	56
Table 2-9 PJM hourly Energy Market HHI (By supply segment): 2011 and 2012	58
Table 2-10 Offer-capping statistics: 2008 to 2012	59
Table 2-11 Real-time offer-capped unit statistics: 2011 and 2012	59
Table 2-12 Three pivotal supplier test details for regional constraints: 2012	60
Table 2-14 Marginal unit contribution to PJM real-time, load-weighted LMP (By parent company): 2012 and 2011	61
Table 2-15 Marginal unit contribution to PJM day-ahead, load-weighted LMP (By parent company): 2012 and 2011	61
Table 2-13 Summary of three pivotal supplier tests applied for regional constraints 2012	61
Table 2-16 Type of fuel used (By real-time marginal units): 2012 and 2011	62
Table 2-17 Day-ahead marginal resources by type/fuel: 2011 and 2012	62
Table 2-18 Average, real-time marginal unit markup index (By price category): 2012 and 2011	63
Table 2-19 Average marginal unit markup index (By offer price category): 2012 and 2011	63
Table 2-20 Markup component of the overall PJM real-time, load-weighted, average LMP by primary fuel type and unit type: 2012 and 2011	64
Table 2-21 Monthly markup components of real-time load-weighted LMP: 2012 and 2011	65
Table 2-22 Average real-time zonal markup component: 2012 and 2011	65
Table 2-23 Average real-time markup component (By price category): 2012 and 2011	66
Table 2-24 Markup component of the overall PJM day-ahead, load-weighted, average LMP by primary fuel type and unit type: 2012 and 2011	66
Table 2-25 Monthly markup components of day-ahead, load-weighted LMP: 2011 and 2012	66
Table 2-26 Day-ahead, average, zonal markup component: 2011 and 2012	67
Table 2-27 Average, day-ahead markup (By LMP category): 2011 and 2012	67

Table 2-28 Number of frequently mitigated units and associated units (By month): 2011 and 2012	68
Table 2-29 Frequently mitigated units and associated units total months eligible: 2011 and 2012	69
Table 2-30 PJM real-time average hourly load: 1998 through 2012	70
Table 2-31 PJM annual Summer THI, Winter WWP and average temperature (Degrees F): Cooling, heating and shoulder months of 2007 through 2012	71
Table 2-32 PJM day-ahead average load: 2001 through 2012	72
Table 2-33 Cleared day-ahead and real-time load (MWh): 2011 and 2012	73
Table 2-34 PJM real-time average hourly generation: 2003 through 2012	74
Table 2-35 PJM day-ahead average hourly generation: 2003 through 2012	75
Table 2-36 Day-ahead and real-time generation (MWh): 2011 and 2012	75
Table 2-37 PJM real-time, average LMP (Dollars per MWh): 1998 through 2012	77
Table 2-38 PJM real-time, load-weighted, average LMP (Dollars per MWh): 1998 through 2012	77
Table 2-39 PJM real-time annual, fuel-cost-adjusted, load-weighted average LMP (Dollars per MWh): Year-over-year method	78
Table 2-40 Components of PJM real-time (Unadjusted), annual, load-weighted, average LMP: 2012 and 2011	79
Table 2-41 Components of PJM real-time (Adjusted), annual, load-weighted, average LMP: 2012 and 2011	80
Table 2-42 PJM day-ahead, average LMP (Dollars per MWh): 2001 through 2012	80
Table 2-43 PJM day-ahead, load-weighted, average LMP (Dollars per MWh): 2001 through 2012	81
Table 2-44 Components of PJM day-ahead, (unadjusted) annual, load-weighted, average LMP (Dollars per MWh): 2012	81
Table 2-45 Components of PJM day-ahead, (adjusted) annual, load-weighted, average LMP (Dollars per MWh): Calendar year 2012	82
Table 2-46 Hourly average volume of cleared and submitted INCs, DECs by month: 2011 and 2012	83
Table 2-47 Hourly average of cleared and submitted up-to congestion bids by month: 2011 and 2012	83
Table 2-48 Type of day-ahead marginal units: 2012	83
Table 2-49 PJM INC and DEC bids by type of parent organization (MW): 2011 and 2012	84
Table 2-50 PJM up-to congestion transactions by type of parent organization (MW): 2011 and 2012	84
Table 2-51 PJM virtual offers and bids by top ten locations (MW): 2011 and 2012	85
Table 2-52 PJM cleared up-to congestion import bids by top ten source and sink pairs (MW): 2011 and 2012	85
Table 2-53 PJM cleared up-to congestion export bids by top ten source and sink pairs (MW): 2011 and 2012	86
Table 2-54 PJM cleared up-to congestion wheel bids by top ten source and sink pairs (MW): 2011 and 2012	87
Table 2-55 PJM cleared up-to congestion internal bids by top ten source and sink pairs (MW): November through December of 2012	88
Table 2-56 Number of PJM offered and cleared source and sink pairs: 2012	88
Table 2-57 PJM cleared up-to congestion transactions by type (MW): 2011 and 2012	89
Table 2-58 Day-ahead and real-time average LMP (Dollars per MWh): 2011 and 2012	90
Table 2-59 Day-ahead and real-time average LMP (Dollars per MWh): 2001 through 2012	90
Table 2-60 Frequency distribution by hours of PJM real-time and day-ahead load-weighted hourly LMP difference (Dollars per MWh): 2007 through 2012	91

Table 2-61 Monthly average percentage of real-time self-supply load, bilateral-supply load and spot-supply load based on parent companies: 2011 through 2012	92
Table 2-62 Monthly average percentage of day-ahead self-supply load, bilateral supply load, and spot-supply load based on parent companies: 2011 through 2012	93
Table 2-63 Maximum Emergency Alerts and Actions	95
Table 2-64 High Load Hour, Hot Weather Alerts and Maximum Emergency Related Events: 2012	96
SECTION 3 OPERATING RESERVE	97
Table 3-1 Day-ahead and balancing operating reserve credits and charges	100
Table 3-2 Reactive services and synchronous condensing credits and charges	100
Table 3-3 Balancing operating reserve cost allocation process	101
Table 3-4 Balancing operating reserve regions	102
Table 3-5 Operating reserve deviations	103
Table 3-6 Total operating reserve charges: 1999 through 2012	104
Table 3-7 Monthly operating reserve charges: 2011 and 2012	104
Table 3-8 Day-ahead operating reserve charges: 2011 and 2012	105
Table 3-9 Balancing operating reserve charges: 2011 and 2012	105
Table 3-10 Balancing operating reserve deviation charges: 2011 and 2012	105
Table 3-11 Reactive services charges: 2011 and 2012	105
Table 3-12 Regional balancing charges allocation: 2011	106
Table 3-13 Regional balancing charges allocation: 2012	106
Table 3-14 Operating reserve rates (\$/MWh): 2011 and 2012	108
Table 3-15 Operating reserve rates statistics (\$/MWh): 2012	108
Table 3-16 Balancing operating reserve determinants (MWh): 2011 and 2012	109
Table 3-17 Credits by operating reserve category: 2011 and 2012	109
Table 3-18 Operating reserve credits by unit type: 2011 and 2012	110
Table 3-19 Operating reserve credits by unit type: 2012	110
Table 3-21 Day-ahead and real-time generation (GWh): 2012	111
Table 3-20 Operating reserve credits paid to wind units: 2011 and 2012	111
Table 3-22 Day-ahead and real-time economic and noneconomic generation (GWh): 2012	112
Table 3-23 Day-ahead and real-time generation receiving operating reserve credits (GWh): 2012	112
Table 3-24 Geography of regional charges and credits: 2012	113
Table 3-25 Monthly balancing operating reserve charges and credits to generators (Eastern Region): 2012	113
Table 3-26 Monthly balancing operating reserve charges and credits to generators (Western Region): 2012	114
Table 3-27 Percentage of unit credits and charges of total credits and charges: 2011 and 2012	114
Table 3-28 Day-ahead and balancing operating reserve for load response credits: 2011 and 2012	115
Table 3-29 Top 10 operating reserve credits units (By percent of total system): 2001 through 2012	116
Table 3-30 Top 10 units and organizations operating reserve credits: 2012	116
Table 3-31 Identification of balancing operating reserve credits received by the top 10 units by category and region: 2012	116
Table 3-32 Daily operating reserve credits HHI: 2012	117
Table 3-33 Average operating reserve rates before and after September 13, 2012	118
Table 3-34 Day-ahead generation from combustion turbines and diesels (GWh): 2011 and 2012	120

Table 3-35 Lost opportunity cost credits paid to combustion turbines and diesels by scenario: 2012	120
Table 3-36 Day-ahead generation (GWh) from combustion turbines and diesels receiving lost opportunity cost credits by value	121
Table 3-39 Lost opportunity cost proposals	123
Table 3-37 Impact on energy market lost opportunity cost credits of rule changes: 2012	123
Table 3-38 Impact on energy market lost opportunity cost credits of proposed rule changes: 2012	123
Table 3-40 Impact of proposed rule change on lost opportunity cost credits paid to wind units: 2012	124
Table 3-41 Impact of credits paid to units providing reactive services on the balancing operating reserve rates (\$/MWh): 2012	126
Table 3-42 Up-to congestion transactions impact on operating reserve rates: 2012	127
SECTION 4 CAPACITY MARKET	129
Table 4-1 The Capacity Market results were competitive	129
Table 4-2 RPM Related MMU Reports	134
Table 4-3 PJM installed capacity (By fuel source): January 1, May 31, June 1, and December 31, 2012	135
Table 4-4 Internal capacity: June 1, 2011 to June 1, 2015	138
Table 4-5 RPM generation capacity additions: 2007/2008 through 2015/2016	139
Table 4-6 PJM Capacity Market load obligation served: June 1, 2012	139
Table 4-7 Preliminary market structure screen results: 2012/2013 through 2015/2016 RPM Auctions	140
Table 4-8 RSI results: 2012/2013 through 2015/2016 RPM Auctions	142
Table 4-9 PJM capacity summary (MW): June 1, 2007 to June 1, 2015	146
Table 4-10 RPM load management statistics by LDA: June 1, 2011 to June 1, 2015	147
Table 4-11 RPM load management cleared capacity and ILR: 2007/2008 through 2015/2016	148
Table 4-12 RPM load management statistics: June 1, 2007 to June 1, 2015	148
Table 4-13 ACR statistics: 2012/2013 RPM Auctions	150
Table 4-14 ACR statistics: 2013/2014 RPM Auctions	150
Table 4-15 ACR statistics: 2014/2015 RPM Auctions	151
Table 4-16 ACR statistics: 2015/2016 RPM Auctions	151
Table 4-17 APIR statistics: 2012/2013 RPM Auctions	152
Table 4-18 APIR statistics: 2013/2014 RPM Auctions	152
Table 4-19 APIR statistics: 2014/2015 RPM Auction	153
Table 4-20 APIR statistics: 2015/2016 RPM Auction	153
Table 4-21 Capacity prices: 2007/2008 through 2015/2016 RPM Auctions	158
Table 4-22 RPM revenue by type: 2007/2008 through 2015/2016	159
Table 4-23 RPM revenue by calendar year: 2007 through 2016	159
Table 4-24 RPM cost to load: 2012/2013 through 2015/2016 RPM Auctions	160
Table 4-25 PJM capacity factor (By unit type (GWh)): 2011 and 2012	161
Table 4-26 EAF by unit type: 2007 through 2012	161
Table 4-27 EMOF by unit type: 2007 through 2012	161
Table 4-28 EPOF by unit type: 2007 through 2012	162
Table 4-29 EFOF by unit type: 2007 through 2012	162
Table 4-30 PJM EFORd data for different unit types: 2007 through 2012	162
Table 4-31 OMC Outages: 2012	164

Table 4-32 PJM EFORd vs. XEFORd: 2012	165
Table 4-33 Contribution to EFOF by unit type by cause: 2012	166
Table 4-34 Contributions to Economic Outages: 2012	166
Table 4-35 PJM EFORd, XEFORd and EFORp data by unit type: 2012	167
SECTION 5 DEMAND-SIDE RESPONSE (DSR)	169
Table 5-1 Overview of Demand Side Programs	171
Table 5-2 Economic Program registration on peak load days: 2002 to 2012	172
Table 5-3 Economic Program registrations on the last day of the month: 2009 through 2012	173
Table 5-4 Distinct registrations and sites in the Economic Program: July 17, 2012	173
Table 5-5 Performance of PJM Economic Program participants excluding incentive payments: 2002 through 2012	173
Table 5-6 PJM Economic Program participation by zone: 2011 and 2012	174
Table 5-7 PJM Economic Program average participation by zone: 2012	175
Table 5-8 Settlement days submitted by month in the Economic Program: 2007 through 2012	175
Table 5-9 Distinct customers and CSPs submitting settlements in the Economic Program by month: 2008 through 2012	175
Table 5-10 Hourly frequency distribution of Economic Program MWh reductions and credits: 2012	176
Table 5-11 Frequency distribution of Economic Program zonal, load-weighted, average LMP (By hours): 2012	176
Table 5-12 Zonal monthly capacity credits: 2012	177
Table 5-13 Registered MW in the Load Management Program by program type: Delivery years 2007/2008 through 2012/2013	178
Table 5-14 PJM declared Load Management Events: 2012	178
Table 5-15 Load Management event performance: July 17, 2012	179
Table 5-16 Load Management event performance: July 18, 2012	179
Table 5-17 Load Management event performance: 2012 Aggregate	180
Table 5-18 Distribution of participant event days across ranges of performance levels across the event in the 2012/2013 Delivery Year compliance period	180
Table 5-19 Distribution of GLD participant event hours and observed load reductions across ranges of load reduction as a percentage of Peak Load Contribution (PLC) for the events in the 2012/2013 Delivery Year	181
Table 5-20 Load Management Event Performance with negatives: 2012	182
Table 5-21 Load Management Event Performance Comparison: Reported Reduction vs. Actual Reduction: 2012	182
Table 5-22 Non Reporting Locations on 2012 Event Days	183
Table 5-23 Non Reporting Locations by MW on 2012 Event Days	183
Table 5-24 Distribution of registrations and associated MW in the Emergency Full Option across ranges of Minimum Dispatch Prices effective for the 2012/2013 Delivery Year	184
Table 5-25 Emergency credits and make whole payments by event: 2012	184
Table 5-26 Load Management test results and compliance by zone for the 2012/2013 delivery year	185
Table 5-27 Load Management Test Results with negatives, excluding retests	185
Table 5-28 Penalty Charges per Zone: Delivery Year 2012/2013	186

SECTION 6 NET REVENUE	189
Table 6-1 Capacity revenue by PJM zones (Dollars per MW-year): 2009 through 2012	193
Table 6-2 PJM-wide net revenue for a CT under economic dispatch by market (Dollars per installed MW-year): 2009 through 2012	193
Table 6-3 Energy Market net revenue for a new entrant gas-fired CT under economic dispatch (Dollars per installed MW-year): 2009 through 2012	193
Table 6-4 Zonal combined net revenue from all markets for a CT under economic dispatch (Dollars per installed MW-year): 2009 through 2012	193
Table 6-5 PJM-wide net revenue for a CC under economic dispatch by market (Dollars per installed MW-year): 2009 through 2012	194
Table 6-6 PJM Energy Market net revenue for a new entrant gas-fired CC under economic dispatch (Dollars per installed MW-year): 2009 through 2012	194
Table 6-7 Zonal combined net revenue from all markets for a CC under economic dispatch (Dollars per installed MW-year): 2009 through 2012	194
Table 6-8 PJM-wide net revenue for a CP by market (Dollars per installed MW-year): 2009 through 2012	194
Table 6-9 PJM Energy Market net revenue for a new entrant CP (Dollars per installed MW-year): 2009 through 2012	195
Table 6-10 Zonal combined net revenue from all markets for a CP (Dollars per installed MW-year): 2009 through 2012	195
Table 6-11 Net revenue for an IGCC by market (Dollars per installed MW-year): 2012	195
Table 6-12 Net revenue for a nuclear plant by market (Dollars per installed MW-year): 2012	195
Table 6-13 Net revenue for a wind installation by market (Dollars per installed MW-year): 2012	195
Table 6-14 Net revenue for a solar installation by market (Dollars per installed MW-year): 2012	196
Table 6-15 New entrant 20-year levelized fixed costs: (By plant type (Dollars per installed MW-year)): 2009 through 2012	196
Table 6-16 Percent of 20-year levelized fixed costs recovered by CT energy and capacity net revenue (Dollars per installed MW-year): 2009 through 2012	196
Table 6-17 Percent of 20-year levelized fixed costs recovered by CC energy and capacity net revenue: 2009 through 2012	197
Table 6-18 Percent of 20-year levelized fixed costs recovered by CP energy and capacity net revenue: 2009 through 2012	198
Table 6-19 Percent of 20-year levelized fixed costs recovered by IGCC energy and capacity net revenue	198
Table 6-20 Percent of 20-year levelized fixed costs recovered by nuclear energy and capacity net revenue	199
Table 6-21 Percent of 20-year levelized fixed costs recovered by wind energy and capacity net revenue and wind credits	199
Table 6-22 Percent of 20-year levelized fixed costs recovered by solar energy and capacity net revenue and solar credits	199
Table 6-23 Internal rate of return sensitivity for CT, CC and CP generators	200
Table 6-24 Debt to equity ratio sensitivity for CT and CC assuming 20 year debt term and 12 percent internal rate of return	200
Table 6-25 Debt term sensitivity for CT and CC assuming 50/50 debt to equity ratio and 12 percent internal rate of return	200
Table 6-26 Interconnection cost sensitivity for CT and CC	201
Table 6-27 Class average net revenue from energy and ancillary markets and associated recovery of class average avoidable costs and total revenue from all markets and associated recovery of class average avoidable costs: 2012	202

Table 6-28 Energy and ancillary service net revenue by quartile for select technologies for 2012	203
Table 6-29 Capacity revenue by quartile for select technologies for 2012	203
Table 6-30 Combined revenue from all markets by quartile for select technologies for 2012	203
Table 6-31 Avoidable cost recovery by quartile from energy and ancillary net revenue for select technologies for 2012	204
Table 6-32 Avoidable cost recovery by quartile from all PJM Markets for select technologies for 2012	204
Table 6-33 Proportion of units recovering avoidable costs from energy and ancillary markets for 2009 to 2012	205
Table 6-34 Proportion of units recovering avoidable costs from all markets for 2009 to 2012	205
Table 6-35 Profile of coal units	206
Table 6-36 Installed capacity associated with levels of avoidable cost recovery: 2012	206
Table 6-37 Coal plants lacking MATS compliant environmental controls	206
SECTION 7 ENVIRONMENTAL AND RENEWABLE ENERGY REGULATIONS	207
Table 7-1 HEDD maximum NO _x emission rates	213
Table 7-2 RGGI CO ₂ allowance auction prices and quantities (tons): 2009-2011 and 2012-2014 Compliance Periods	214
Table 7-3 Renewable standards of PJM jurisdictions to 2022,	215
Table 7-4 Solar renewable standards of PJM jurisdictions to 2022	215
Table 7-5 Additional renewable standards of PJM jurisdictions to 2021	216
Table 7-6 Renewable alternative compliance payments in PJM jurisdictions: 2012	216
Table 7-7 Renewable generation by jurisdiction and renewable resource type (GWh): 2012	217
Table 7-8 PJM renewable capacity by jurisdiction (MW), on December 31, 2012	217
Table 7-10 SO ₂ emission controls (FGD) by unit type (MW), as of December 31, 2012	218
Table 7-11 NO _x emission controls by unit type (MW), as of December 31, 2012	218
Table 7-12 Particulate emission controls by unit type (MW), as of December 31, 2012	219
Table 7-13 Capacity factor of wind units in PJM: 2012	219
Table 7-14 Wind resources in real time offering at a negative price in PJM: 2012	219
Table 7-15 Capacity factor of wind units in PJM by month, 2011 and 2012	220
SECTION 8 INTERCHANGE TRANSACTIONS	223
Table 8-1 Real-time scheduled net interchange volume by interface (GWh): 2012	229
Table 8-2 Real-time scheduled gross import volume by interface (GWh): 2012	229
Table 8-3 Real-time scheduled gross export volume by interface (GWh): 2012	230
Table 8-4 Real-time scheduled net interchange volume by interface pricing point (GWh): 2012	232
Table 8-5 Real-time scheduled gross import volume by interface pricing point (GWh): 2012	233
Table 8-6 Real-time scheduled gross export volume by interface pricing point (GWh): 2012	233
Table 8-7 Day-Ahead scheduled net interchange volume by interface (GWh): 2012	236
Table 8-8 Day-Ahead scheduled gross import volume by interface (GWh): 2012	236
Table 8-9 Day-Ahead scheduled gross export volume by interface (GWh): 2012	237
Table 8-10 Day-Ahead scheduled net interchange volume by interface pricing point (GWh): 2012	238
Table 8-11 Up-to Congestion scheduled net interchange volume by interface pricing point (GWh): 2012	239
Table 8-12 Day-Ahead scheduled gross import volume by interface pricing point (GWh): 2012	239
Table 8-13 Up-to Congestion scheduled gross import volume by interface pricing point (GWh): 2012	240

Table 8-14 Day-Ahead scheduled gross export volume by interface pricing point (GWh): 2012	240
Table 8-15 Up-to Congestion scheduled gross export volume by interface pricing point (GWh): 2012	241
Table 8-16 Active interfaces: 2012	241
Table 8-17 Active pricing points: 2012	242
Table 8-18 Net scheduled and actual PJM flows by interface (GWh): 2012	243
Table 8-19 Net scheduled and actual PJM flows by interface pricing point (GWh): 2012	244
Table 8-20 Net scheduled and actual PJM flows by interface pricing point (GWh) (Adjusted for IMO Scheduled Interfaces): 2012	245
Table 8-21 Net scheduled and actual PJM flows by interface and interface pricing point (GWh): 2012	246
Table 8-22 Net scheduled and actual PJM flows by interface pricing point and interface (GWh): 2012	247
Table 8-23 Distribution of economic and uneconomic hourly flows between PJM and MISO: 2012	249
Table 8-24 Distribution of economic and uneconomic hourly flows between PJM and NYISO: 2012	251
Table 8-25 Real-time average hourly LMP comparison for Duke, PEC and NCMIPA: 2012	255
Table 8-26 Day-ahead average hourly LMP comparison for Duke, PEC and NCMIPA: 2012	255
Table 8-27 Con Edison and PSE&G wheeling agreement data: 2012	257
Table 8-28 PJM and MISO TLR procedures: January, 2010 through December, 2012	257
Table 8-29 Number of TLRs by TLR level by reliability coordinator: 2012	258
Table 8-30 Monthly volume of cleared and submitted up-to congestion bids: January, 2009 through December, 2012	260
Table 8-31 Monthly uncollected congestion charges: 2010 through 2012	263
SECTION 9 ANCILLARY SERVICE MARKETS	265
Table 9-1 The Regulation Market results were not competitive for the first three quarters and were indeterminate for the fourth quarter	265
Table 9-2 The Synchronized Reserve Markets results were competitive	266
Table 9-3 The Day-Ahead Scheduling Reserve Market results were competitive	266
Table 9-4 History of ancillary services costs per MW of Load: 2001 through 2012	270
Table 9-5 PJM regulation capability, daily offer and hourly eligible: 2011 and 2012	273
Table 9-6 Impact on PJM Regulation Market of currently regulating units scheduled to retire through 2015	273
Table 9-7 PJM Regulation Market required MW and ratio of eligible supply to requirement: Calendar years 2011 and 2012	275
Table 9-8 PJM cleared regulation HHI: 2011 and 2012	275
Table 9-9 Regulation market monthly three pivotal supplier results: 2010, 2011 and 2012	276
Table 9-10 Regulation sources: spot market, self-scheduled, bilateral purchases: 2011 and 2012	276
Table 9-11 PJM Regulation Market monthly weighted average market-clearing price, marginal unit opportunity cost and offer price (Dollars per MWh): January through December 2012	277
Table 9-12 Total regulation charges: 2012 and 2011	278
Table 9-13 Components of regulation cost: 2012	278
Table 9-14 Comparison of average price and cost for PJM Regulation, 2006 through 2012	278
Table 9-15 Shortage Pricing penalty factors: June 2012 through May 2016	281

Table 9-16 Synchronized Reserve Market required MW, RTO Zone and Mid-Atlantic Dominion Subzone, December 2008 through December 2012	282
Table 9-17 Synchronized Reserve market monthly three pivotal supplier results: 2010, 2011 and 2012	284
Table 9-18 Average RFC SRMCP when all cleared synchronized reserve is DSR, average SRMCP, and percent of all cleared hours that all cleared synchronized reserve is DSR: January through December 2010, 2011, 2012	285
Table 9-19 Mid-Atlantic Dominion Sub-zone weighted synchronized reserve market clearing prices, credits, and MWs: 2012	285
Table 9-20 Comparison of yearly weighted average price and cost for PJM Synchronized Reserve, 2005 through 2012	286
Table 9-21 Tier 2 synchronized reserve purchases by month for the Mid-Atlantic Dominion Subzone: 2012	286
Table 9-22 Spinning Events, January 2009 through December 2012	288
Table 9-23 PJM Day-Ahead Scheduling Reserve Market MW and clearing prices: January through December 2011 and 2012	290
Table 9-24 Black start yearly zonal charges for network transmission use: 2012	292
SECTION 10 CONGESTION AND MARGINAL LOSSES	293
Table 10-1 PJM real-time, load-weighted average LMP components (Dollars per MWh): 2009 through 2012	297
Table 10-2 PJM day-ahead, load-weighted average LMP components (Dollars per MWh): 2009 through 2012	298
Table 10-3 Zonal and PJM real-time, load-weighted average LMP components (Dollars per MWh): 2011 and 2012	299
Table 10-4 Zonal and PJM day-ahead, load-weighted average LMP components (Dollars per MWh): 2011 and 2012	299
Table 10-5 Total PJM costs by component (Dollars (Millions)): 2009 through 2012	301
Table 10-7 Total PJM energy costs by market category (Dollars (Millions)): 2009 through 2012	301
Table 10-8 Monthly energy costs by type (Dollars (Millions)): 2011 and 2012	301
Table 10-6 Total PJM energy costs by category (Dollars (Millions)): 2009 through 2012	301
Table 10-9 Total PJM Marginal Loss Component Costs (Dollars (Millions)): 2009 through 2012	303
Table 10-10 Total PJM marginal loss costs by category (Dollars (Millions)): 2009 through 2012	303
Table 10-11 Total PJM marginal loss costs by market category (Dollars (Millions)): 2009 through 2012	303
Table 10-12 Monthly marginal loss costs by type (Dollars (Millions)): 2011 and 2012	303
Table 10-13 Marginal loss credits (Dollars (Millions)): 2009 through 2012	304
Table 10-14 Total PJM congestion (Dollars (Millions)): 2008 to 2012	306
Table 10-15 Total PJM congestion costs by category (Dollars (Millions)): 2011 to 2012	306
Table 10-16 Total PJM congestion costs by market category (Dollars (Millions)): 2011 to 2012	307
Table 10-17 Monthly PJM congestion costs (Dollars (Millions)): 2012	307
Table 10-18 Monthly PJM congestion costs (Dollars (Millions)): 2011	307
Table 10-19 Congestion summary (By facility type): 2012	309
Table 10-20 Congestion summary (By facility type): 2011	309
Table 10-21 Congestion Event Hours (Day Ahead against Real Time): Calendar years 2011 to 2012	309
Table 10-22 Congestion Event Hours (Real Time against Day Ahead): 2011 to 2012	309
Table 10-23 Congestion summary (By facility voltage): 2012	310
Table 10-24 Congestion summary (By facility voltage): 2011	310

Table 10-25 Top 25 constraints with frequent occurrence: 2011 to 2012	311
Table 10-26 Top 25 constraints with largest year-to-year change in occurrence: 2011 to 2012	311
Table 10-27 Top 25 constraints affecting PJM congestion costs (By facility): 2012	312
Table 10-28 Top 25 constraints affecting PJM congestion costs (By facility): 2011	313
Table 10-29 Top congestion cost impacts from MISO flowgates affecting PJM dispatch (By facility): 2012	314
Table 10-30 Top congestion cost impacts from MISO flowgates affecting PJM dispatch (By facility): 2011	315
Table 10-31 Regional constraints summary (By facility): 2012	315
Table 10-32 Regional constraints summary (By facility): 2011	316
Table 10-33 Congestion cost by the type of the participant: Calendar year 2012	316
Table 10-34 Congestion cost by the type of the participant: Calendar year 2011	316
SECTION 11 GENERATION AND TRANSMISSION PLANNING	317
Table 11-1 Year-to-year capacity additions from PJM generation queue: Calendar years 2000 through 2012	318
Table 11-2 Queue comparison (MW): December 31, 2012 vs. December 31, 2011	319
Table 11-3 Capacity in PJM queues (MW): At December 31, 2012,	319
Table 11-4 Average project queue times (days): At December 31, 2012	320
Table 11-5 Active capacity queued to be in service prior to January 1, 2013	320
Table 11-6 Capacity additions in active or under-construction queues by control zone (MW): At December 31, 2012	321
Table 11-7 Capacity additions in active or under-construction queues by LDA (MW): At December 31, 2012	321
Table 11-8 Existing PJM capacity: At January 1, 2013 (By zone and unit type (MW))	322
Table 11-9 PJM capacity (MW) by age: at January 1, 2013	322
Table 11-10 Comparison of generators 40 years and older with slated capacity additions (MW): Through 2018	323
Table 11-11 Summary of PJM unit retirements (MW): 2011 through 2019	324
Table 11-12 Planned deactivations of PJM units after 2012, as of March 1, 2013	325
Table 11-13 HEDD Units in PJM as of January 1, 2013	325
Table 11-14 Unit deactivations: January 2012 through January 1, 2013	326
Table 11-15 Major upgrade projects in Eastern Region	327
Table 11-16 Major upgrade projects in Western Region	327
Table 11-17 Major upgrade projects in Southern Region	328
SECTION 12 FINANCIAL TRANSMISSION AND AUCTION REVENUE RIGHTS	331
Table 12-1 The FTR Auction Markets results were competitive	332
Table 12-2 Top 10 principal binding transmission constraints limiting the Long Term FTR Auction: Planning periods 2013 to 2016	338
Table 12-3 Top 10 principal binding transmission constraints limiting the Annual FTR Auction: Planning period 2012 to 2013	339
Table 12-4 Long Term FTR Auction patterns of ownership by FTR direction: Planning periods 2013 to 2016	341
Table 12-5 Annual FTR Auction patterns of ownership by FTR direction: Planning period 2012 to 2013	341
Table 12-6 Monthly Balance of Planning Period FTR Auction patterns of ownership by FTR direction: January through December 2012	341
Table 12-7 Daily FTR net position ownership by FTR direction: January through December 2012	341

Table 12-8 Directly allocated FTR volume for DEOK Control Zone: January 1, 2012 through May 31, 2012	342
Table 12-9 Directly allocated FTR volume for ATSI and DEOK Control Zones: Planning period 2012 to 2013	342
Table 12-10 Long Term FTR Auction market volume: Planning periods 2013 to 2016	343
Table 12-11 Annual FTR Auction market volume: Planning period 2012 to 2013	344
Table 12-12 Comparison of self-scheduled FTRs: Planning periods from 2008 to 2009 through 2012 to 2013	345
Table 12-13 Monthly Balance of Planning Period FTR Auction market volume: January through December 2012	345
Table 12-14 Monthly Balance of Planning Period FTR Auction buy-bid, bid and cleared volume (MW per period): January through June 2012	346
Table 12-15 Secondary bilateral FTR market volume: Planning periods 2011 to 2012 and 2012 to 2013	347
Table 12-16 Long Term FTR Auction weighted-average cleared prices (Dollars per MW): Planning periods 2013 to 2016	348
Table 12-17 Annual FTR Auction weighted-average cleared prices (Dollars per MW): Planning period 2012 to 2013	349
Table 12-18 Monthly Balance of Planning Period FTR Auction cleared, weighted-average, buy-bid price per period (Dollars per MW): January through December 2012	350
Table 12-19 FTR profits by organization type and FTR direction: January through December 2012	350
Table 12-20 Monthly FTR profits by organization type: January through December 2012	351
Table 12-21 Long Term FTR Auction revenue: Planning periods 2013 to 2016	351
Table 12-22 Annual FTR Auction revenue: Planning period 2012 to 2013	353
Table 12-23 Monthly Balance of Planning Period FTR Auction revenue: January through December 2012	355
Table 12-24 Total annual PJM FTR revenue detail (Dollars (Millions)): Planning periods 2011 to 2012 and 2012 to 2013 through December 31, 2012	358
Table 12-25 Monthly FTR accounting summary (Dollars (Millions)): Planning periods 2011 to 2012 and 2012 to 2013	359
Table 12-26 Reported FTR payout ratio by planning period	360
Table 12-27 Reported and Actual Payout Ratios for 2012	360
Table 12-28 Example of FTR payouts from portfolio netting and without portfolio netting	361
Table 12-29 Monthly positive and negative target allocations and payout ratios with and without hourly netting in 2012	362
Table 12-30 Counter flow FTR payout ratio adjustment impacts	363
Table 12-31 Top 10 principal binding transmission constraints limiting the annual ARR allocation: Planning period 2012 to 2013	366
Table 12-32 ARRs and ARR revenue automatically reassigned for network load changes by control zone: June 1, 2011, through December 31, 2012	366
Table 12-33 Incremental ARR allocation volume: Planning periods 2008 to 2009 through 2012 to 2013	367
Table 12-34 IARRs allocated for 2012 to 2013 Annual ARR Allocation for RTEP upgrades	367
Table 12-35 Residual ARR allocation volume and target allocation	368
Table 12-36 Annual ARR allocation volume: Planning periods 2011 to 2012 and 2012 to 2013	368
Table 12-37 Constraints with capacity increases due to Stage 1A infeasibility for the 2012 to 2013 ARR Allocation	369
Table 12-38 ARR revenue adequacy (Dollars (Millions)): Planning periods 2011 to 2012 and 2012 to 2013	369

Table 12-39 ARR and self-scheduled FTR congestion offset (in millions) by control zone: Planning period 2012 to 2013	371
Table 12-40 ARR and FTR congestion offset (in millions) by control zone: Planning period 2012 to 2013	372
Table 12-41 ARR and FTR congestion hedging (in millions): Planning periods 2011 to 2012 and 2012 to 2013 through December 31, 2012	372
APPENDIX C ENERGY MARKET	379
Table C-1 Frequency distribution of PJM real-time, hourly load: 2007 to 2012	379
Table C-2 Off-peak and on-peak load (MW): 1998 to 2012	380
Table C-3 Multiyear change in load: 1998 to 2012	380
Table C-4 Frequency distribution by hours of PJM Real-Time Energy Market LMP (Dollars per MWh): 2007 to 2012	381
Table C-5 Off-peak and on-peak, PJM load-weighted, average LMP (Dollars per MWh): 2011 to 2012	382
Table C-6 On-peak and off-peak real-time PJM fuel-cost-adjusted, load-weighted, average LMP (Dollars per MWh): 2012	382
Table C-7 PJM real-time load-weighted, average LMP during constrained hours (Dollars per MWh): 2011 to 2012	382
Table C-8 PJM real-time load-weighted, average LMP during constrained and unconstrained hours (Dollars per MWh): 2011 to 2012	383
Table C-9 PJM real-time constrained hours: 2011 to 2012	383
Table C-10 Frequency distribution by hours of PJM Day-Ahead Energy Market LMP (Dollars per MWh): 2007 to 2012	384
Table C-11 Off-peak and on-peak, average day-ahead and real-time LMP (Dollars per MWh): 2012	384
Table C-12 On-peak, zonal, average day-ahead and real-time LMP (Dollars per MWh): 2011 and 2012	386
Table C-13 Off-peak, zonal, average day-ahead and real-time LMP (Dollars per MWh): 2011 and 2012	386
Table C-14 PJM day-ahead and real-time, market-constrained hours: 2012	387
Table C-15 PJM average LMP during constrained and unconstrained hours (Dollars per MWh): 2012	387
Table C-16 Zonal real-time, average LMP (Dollars per MWh): 2011 and 2012	387
Table C-17 Jurisdiction real-time, average LMP (Dollars per MWh): 2011 and 2012	387
Table C-18 Hub real-time, average LMP (Dollars per MWh): 2011 and 2012	388
Table C-19 Zonal real-time, load-weighted, average LMP (Dollars per MWh): 2011 and 2012	388
Table C-20 Jurisdiction real-time, load-weighted, average LMP (Dollars per MWh): 2011 and 2012	388
Table C-21 Zonal day-ahead, average LMP (Dollars per MWh): 2011 and 2012	388
Table C-22 Jurisdiction day-ahead, average LMP (Dollars per MWh): 2011 and 2012	389
Table C-23 Zonal day-ahead, load-weighted, average LMP (Dollars per MWh): 2011 and 2012	389
Table C-24 Jurisdiction day-ahead, load weighted LMP (Dollars per MWh): 2011 and 2012	389
Table C-25 Zonal day-ahead and real-time average LMP (Dollars per MWh): 2012	389
Table C-26 Jurisdiction day-ahead and real-time average LMP (Dollars per MWh): 2012	390
Table C-27 Average day-ahead, offer-capped units: 2008 to 2012	391
Table C-28 Average day-ahead, offer-capped MW: 2008 to 2012	391
Table C-29 Average real-time, offer-capped units: 2008 to 2012	391
Table C-30 Average real-time, offer-capped MW: 2008 to 2012	392

Table C-31 Offer-capped unit statistics: 2008	392
Table C-32 Offer-capped unit statistics: 2009	392
Table C-33 Offer-capped unit statistics: 2010	393
Table C-34 Offer-capped unit statistics: 2011	393
Table C-35 Offer-capped unit statistics: 2012	393
APPENDIX D LOCAL ENERGY MARKET STRUCTURE: TPS RESULTS	395
Table D-1 Three pivotal supplier test details for constraints located in the AP Control Zone: 2012	395
Table D-2 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the AP Control Zone: 2012	395
Table D-3 Three pivotal supplier test details for constraints located in the ATSI Control Zone: 2012	396
Table D-4 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the ATSI Control Zone: 2012	396
Table D-5 Three pivotal supplier test details for constraints located in the BGE Control Zone: 2012	397
Table D-6 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the BGE Control Zone: 2012	397
Table D-7 Three pivotal supplier test details for constraints located in the ComEd Control Zone: 2012	398
Table D-8 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the ComEd Control Zone: 2012	398
Table D-9 Three pivotal supplier test details for constraints located in the DEOK Control Zone: 2012	398
Table D-10 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the DEOK Control Zone: 2012	398
Table D-11 Three pivotal supplier test details for constraints located in the DLCO Control Zone: 2012	399
Table D-12 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the DLCO Control Zone: 2012	399
Table D-15 Three pivotal supplier test details for constraints located in the DPL Control Zone: 2012	400
Table D-16 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the DPL Control Zone: 2012	400
Table D-13 Three pivotal supplier test details for constraints located in the Dominion Control Zone: 2012	400
Table D-14 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the Dominion Control Zone: 2012	400
Table D-17 Three pivotal supplier test details for constraints located in the PECO Control Zone: 2012	401
Table D-18 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the PECO Control Zone: 2012	401
Table D-19 Three pivotal supplier test details for constraints located in the Pepco Control Zone: 2012	401
Table D-20 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the Pepco Control Zone: 2012	401
Table D-21 Three pivotal supplier test details for constraints located in the PSEG Control Zone: 2012	402

Table D-22 Summary of three pivotal supplier tests applied to uncommitted units for constraints located in the PSEG Control Zone: 2012	402
APPENDIX E INTERCHANGE TRANSACTIONS	403
Table E-1 TLRs by level and reliability coordinator: 2004 through 2012	408
Table E-2 Con Edison and PSE&G wheel settlements data: 2012	412
APPENDIX G CONGESTION AND MARGINAL LOSSES	421
Table G-1 PJM real-time, average LMP components (Dollars per MWh): 2008 through 2012	421
Table G-2 Zonal real-time, average LMP components (Dollars per MWh): 2011 and 2012	422
Table G-3 Hub real-time, average LMP components (Dollars per MWh): 2011 and 2012	422
Table G-4 PJM day-ahead, average LMP components (Dollars per MWh): 2008 through 2012	422
Table G-5 Zonal day-ahead, average LMP components (Dollars per MWh): 2011 and 2012	423
Table G-6 Congestion cost summary (By control zone): 2012	424
Table G-7 Congestion cost summary (By control zone): 2011	425
Table G-8 AECO Control Zone top congestion cost impacts (By facility): 2012	426
Table G-9 AECO Control Zone top congestion cost impacts (By facility): 2011	426
Table G-10 BGE Control Zone top congestion cost impacts (By facility): 2012	427
Table G-11 BGE Control Zone top congestion cost impacts (By facility): 2011	427
Table G-12 DPL Control Zone top congestion cost impacts (By facility): 2012	428
Table G-13 DPL Control Zone top congestion cost impacts (By facility): 2011	428
Table G-14 JCPL Control Zone top congestion cost impacts (By facility): 2012	429
Table G-15 JCPL Control Zone top congestion cost impacts (By facility): 2011	429
Table G-16 Met-Ed Control Zone top congestion cost impacts (By facility): 2012	430
Table G-17 Met-Ed Control Zone top congestion cost impacts (By facility): 2011	430
Table G-18 PECO Control Zone top congestion cost impacts (By facility): 2012	431
Table G-19 PECO Control Zone top congestion cost impacts (By facility): 2011	431
Table G-20 PENELEC Control Zone top congestion cost impacts (By facility): 2012	432
Table G-21 PENELEC Control Zone top congestion cost impacts (By facility): 2011	432
Table G-22 Pepco Control Zone top congestion cost impacts (By facility): 2012	433
Table G-23 Pepco Control Zone top congestion cost impacts (By facility): 2011	433
Table G-24 PPL Control Zone top congestion cost impacts (By facility): 2012	434
Table G-25 PPL Control Zone top congestion cost impacts (By facility): 2011	434
Table G-26 PSEG Control Zone top congestion cost impacts (By facility): 2012	435
Table G-27 PSEG Control Zone top congestion cost impacts (By facility): 2011	435
Table G-28 RECO Control Zone top congestion cost impacts (By facility): 2012	436
Table G-29 RECO Control Zone top congestion cost impacts (By facility): 2011	436
Table G-30 AEP Control Zone top congestion cost impacts (By facility): 2012	437
Table G-31 AEP Control Zone top congestion cost impacts (By facility): 2011	437
Table G-32 AP Control Zone top congestion cost impacts (By facility): 2012	438
Table G-33 AP Control Zone top congestion cost impacts (By facility): 2011	438
Table G-34 ATSI Control Zone top congestion cost impacts (By facility): 2012	439
Table G-35 ATSI Control Zone top congestion cost impacts (By facility): 2011	439
Table G-36 ComEd Control Zone top congestion cost impacts (By facility): 2012	440
Table G-37 ComEd Control Zone top congestion cost impacts (By facility): 2011	440
Table G-38 DAY Control Zone top congestion cost impacts (By facility): 2012	441
Table G-39 DAY Control Zone top congestion cost impacts (By facility): 2011	441
Table G-40 DEOK Control Zone top congestion cost impacts (By facility): 2012	442

Table G-41 DLCO Control Zone top congestion cost impacts (By facility): 2012	443
Table G-42 DLCO Control Zone top congestion cost impacts (By facility): 2011	443
Table G-43 Dominion Control Zone top congestion cost impacts (By facility): 2012	444
Table G-44 Dominion Control Zone top congestion cost impacts (By facility): 2011	444
Table G-45 Marginal loss costs by control zone and type (Dollars (Millions)): 2012	445
Table G-46 Monthly marginal loss costs by control zone (Dollars (Millions)): 2011 and 2012	446
Table G-47 Energy costs by control zone and type (Dollars (Millions)): 2012	447
Table G-48 Monthly energy costs by control zone (Dollars (Millions)): 2011 and 2012	448
APPENDIX H FTR VOLUMES	449
Table H-1 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2003 to 2004	449
Table H-2 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2004 to 2005	449
Table H-3 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2005 to 2006	449
Table H-4 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2006 to 2007	449
Table H-5 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2007 to 2008	449
Table H-6 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2008 to 2009	450
Table H-7 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2009 to 2010	450
Table H-8 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2010 to 2011	450
Table H-9 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2011 to 2012	450
Table H-10 Annual and Monthly FTR Auction bid and cleared volume: Planning period 2012 to 2013	450

FIGURES

SECTION 1 INTRODUCTION	1
Figure 1-1 PJM's footprint and its 19 control zones	2
SECTION 2 ENERGY MARKET	49
Figure 2-1 Average PJM aggregate supply curves: Summer 2011 and 2012	53
Figure 2-2 PJM footprint calendar year peak loads: 1999 to 2012	56
Figure 2-3 PJM peak-load comparison: Tuesday, July 17, 2012, and Thursday, July 21, 2011	57
Figure 2-4 PJM hourly Energy Market HHI: 2012	58
Figure 2-5 Frequently mitigated units and associated units (By month): February, 2006 through December, 2012	68
Figure 2-6 Frequently mitigated units and associated units total months eligible: February, 2006 through December, 2012	69
Figure 2-7 PJM real-time accounting load: 2011 and 2012	70
Figure 2-8 PJM real-time monthly average hourly load: 2011 and 2012	70
Figure 2-9 PJM day-ahead load: 2011 and 2012	71
Figure 2-10 PJM day-ahead monthly average hourly load: 2011 and 2012	72
Figure 2-11 Day-ahead and real-time loads (Average hourly volumes): 2012	73
Figure 2-12 Difference between day-ahead and real-time loads (Average daily volumes): 2011 and 2012	73
Figure 2-13 Day-ahead and real-time generation (Average hourly volumes): 2012	76
Figure 2-14 Difference between day-ahead and real-time generation (Average daily volumes): 2011 and 2012	76
Figure 2-15 Average LMP for the PJM Real-Time Energy Market: 2011 and 2012	77
Figure 2-16 PJM real-time, monthly, load-weighted, average LMP: 2007 through 2012	77
Figure 2-17 Spot average fuel price comparison: 2011 and 2012 (\$/MMBtu)	78
Figure 2-18 Average spot fuel cost of generation of CP, CT, and CC: 2011 and 2012	78
Figure 2-19 Price for the PJM Day-Ahead Energy Market: 2011 and 2012	80
Figure 2-20 Day-ahead, monthly, load-weighted, average LMP: 2007 through 2012	81
Figure 2-21 PJM day-ahead aggregate supply curves: 2012 example day	82
Figure 2-22 Hourly volume of bid and cleared INC, DEC and Up-to Congestion bids (MW) by month: January, 2005 through December, 2012	84
Figure 2-23 PJM cleared up-to congestion transactions by type (MW): 2005 through 2012	89
Figure 2-24 Real-time load-weighted hourly LMP minus day-ahead load-weighted hourly LMP: 2012	90
Figure 2-25 Monthly average of real-time minus day-ahead LMP: 2012	91
Figure 2-26 PJM system hourly average LMP: 2012	91
SECTION 3 OPERATING RESERVE	97
Figure 3-1 Weekly weighted average day-ahead operating reserve rate (\$/MWh): 2011 and 2012	106
Figure 3-2 Daily balancing operating reserve reliability rates (\$/MWh): 2011 and 2012	107
Figure 3-3 Daily balancing operating reserve deviation rates (\$/MWh): 2011 and 2012	107
Figure 3-4 Daily lost opportunity cost and canceled resources rates (\$/MWh): 2011 and 2012	107
Figure 3-5 Daily average day-ahead generation from units scheduled as must run by PJM: 2012	118

Figure 3-6 Units scheduled as must run by PJM receiving day-ahead operating reserve credits: 2012	119
SECTION 4 CAPACITY MARKET	129
Figure 4-1 PJM Locational Deliverability Areas	143
Figure 4-2 PJM RPM EMAAC subzonal LDAs	144
Figure 4-3 History of capacity prices: Calendar year 1999 through 2015	160
Figure 4-4 PJM equivalent outage and availability factors: 2007 to 2012	161
Figure 4-5 Trends in the PJM equivalent demand forced outage rate (EFORd): 2007 through 2012	162
Figure 4-6 PJM 2012 distribution of EFORd data by unit type	163
Figure 4-7 PJM EFORd, XEFORd and EFORp: 2012	167
Figure 4-8 PJM monthly generator performance factors: 2012	167
SECTION 5 DEMAND-SIDE RESPONSE (DSR)	169
Figure 5-1 Demand Response revenue by market: 2002 through 2012	172
Figure 5-2 Economic Program payments by month: 2007 through 2012	174
Figure 5-3 Distribution of participant event days across ranges of performance levels across the event in the 2012/2013 Delivery Year compliance period	181
SECTION 6 NET REVENUE	189
Figure 6-1 Energy Market net revenue factor trends: December 2008 through December 2012	191
Figure 6-2 New entrant CT net revenue and 20-year levelized fixed cost (Dollars per installed MW-year): 2009 through 2012	197
Figure 6-3 New entrant CT net revenue and 20-year levelized fixed cost by LDA (Dollars per installed MW-year): 2009 through 2012	197
Figure 6-4 New entrant CC net revenue and 20-year levelized fixed cost (Dollars per installed MW-year): 2009 through 2012	197
Figure 6-5 New entrant CC net revenue and 20-year levelized fixed cost by LDA (Dollars per installed MW-year): 2009 through 2012	198
Figure 6-6 New entrant CP net revenue and 20-year levelized fixed cost (Dollars per installed MW-year): 2009 through 2012	198
Figure 6-7 New entrant CP net revenue and 20-year levelized fixed cost by LDA (Dollars per installed MW-year): 2009 through 2012	198
SECTION 7 ENVIRONMENTAL AND RENEWABLE ENERGY REGULATIONS	207
Figure 7-1 Spot monthly average emission price comparison: 2011 and 2012	214
Figure 7-2 Average hourly real-time generation of wind units in PJM: 2012	220
Figure 7-3 Average hourly day-ahead generation of wind units in PJM: 2012	221
Figure 7-4 Marginal fuel at time of wind generation in PJM: 2012	221
Figure 7-5 Average hourly real-time generation of solar units in PJM: 2012	222
SECTION 8 INTERCHANGE TRANSACTIONS	223
Figure 8-1 PJM real-time and day-ahead scheduled imports and exports: 2012	227
Figure 8-2 PJM real-time and day-ahead scheduled import and export transaction volume history: 2012	227
Figure 8-3 PJM's footprint and its external interfaces	242

Figure 8-4 Real-time and day-ahead daily hourly average price difference (MISO Interface minus PJM/MISO): 2012	248
Figure 8-5 Real-time and day-ahead daily hourly average price difference (NY proxy - PJM/NYIS): 2012	250
Figure 8-6 PJM, NYISO and MISO real-time and day-ahead border price averages: 2012	251
Figure 8-7 Neptune hourly average flow: 2012	252
Figure 8-8 Linden hourly average flow: 2012	252
Figure 8-9 Credits for coordinated congestion management: 2012	254
Figure 8-10 Monthly up-to congestion cleared bids in MWh: January, 2006 through December, 2012	259
Figure 8-11 Spot import service utilization: January, 2009 through December, 2012	263
SECTION 9 ANCILLARY SERVICE MARKETS	265
Figure 9-1 Average performance score grouped by unit type and regulation signal type: October-December 2012	272
Figure 9-2 Daily average actual cleared MW of regulation, effective cleared MW of regulation, and average performance score; all cleared regulation; October through December, 2012	274
Figure 9-3 Daily average actual cleared MW of regulation, effective cleared MW of regulation, and average performance score; RegD units only; October through December, 2012	274
Figure 9-4 PJM Regulation Market HHI distribution: 2011 and 2012	275
Figure 9-5 Off peak and on peak regulation levels: 2012	276
Figure 9-6 PJM Regulation Market daily weighted average market-clearing price, marginal unit opportunity cost and offer price (Dollars per MWh): 2012	277
Figure 9-7 PJM RTO primary reserve requirement: October through December 2012	279
Figure 9-8 Components of Mid-Atlantic Sub-Zone Primary Reserve (Daily Averages): October through December, 2012	279
Figure 9-9 Mid-Atlantic Dominion Synchronized Reserve Subzone monthly average synchronized reserve required vs. Tier 2 scheduled MW: January through December 2012	283
Figure 9-10 Tier 2 synchronized reserve average hourly offer volume (MW): October through December 2012	284
Figure 9-11 Average daily Tier 2 synchronized reserve offer by unit type (MW): October through December 2012	284
Figure 9-12 Comparison of Mid-Atlantic Dominion Subzone Tier 2 synchronized reserve weighted average price and cost (Dollars per MW): January through December 2012	286
Figure 9-13 Impact of Tier 2 synchronized reserve added MW to the Mid-Atlantic Dominion Sub-Zone: 2012	287
Figure 9-14 Spinning events duration distribution curve, 2009 to 2012	287
Figure 9-15 Daily average Non-Synchronized Reserve Market clearing price and MW cleared: October through December 2012	289
Figure 9-16 Hourly components of DASR clearing price: January through December 2012	291
SECTION 10 CONGESTION AND MARGINAL LOSSES	293
Figure 10-1 PJM monthly congestion (Dollars (Millions)): 2008 to 2012	306
Figure 10-2 Location of the top 10 constraints affecting PJM congestion costs: 2012	313
SECTION 11 GENERATION AND TRANSMISSION PLANNING	317
Figure 11-1 Unit retirements in PJM: 2012 through 2019	324

SECTION 12 FINANCIAL TRANSMISSION AND AUCTION REVENUE RIGHTS	331
Figure 12-1 Geographic location of top ten binding constraints for the 2013 to 2016 Long Term and 2012 to 2013 Annual FTR Auctions and 2012 to 2013 Annual ARR allocation	339
Figure 12-2 Monthly FTR Forfeitures for physical and financial participants: June 2010 through December 2012	342
Figure 12-3 Cleared auction volume (MW) as a percent of total FTR cleared volume by calendar month: June 2004 through December 2012	347
Figure 12-4 Long Term, Annual and Monthly FTR Auction bid and cleared volume: June 2003 through December 2012	347
Figure 12-5 Long Term FTR Auction clearing price per MW frequency: Planning periods 2013 to 2016	348
Figure 12-6 Annual FTR Auction clearing price per MW: Planning period 2012 to 2013	349
Figure 12-7 Ten largest positive and negative revenue producing FTR sinks purchased in the Long Term FTR Auction: Planning periods 2013 to 2016	352
Figure 12-8 Ten largest positive and negative revenue producing FTR sources purchased in the Long Term FTR Auction: Planning periods 2013 to 2016	352
Figure 12-9 Ten largest positive and negative revenue producing FTR sinks purchased in the Annual FTR Auction: Planning period 2012 to 2013	353
Figure 12-10 Ten largest positive and negative revenue producing FTR sources purchased in the Annual FTR Auction: Planning period 2012 to 2013	354
Figure 12-11 Ten largest positive and negative revenue producing FTR sinks purchased in the Monthly Balance of Planning Period FTR Auctions: Planning period 2012 to 2013	354
Figure 12-12 Ten largest positive and negative revenue producing FTR sources purchased in the Monthly Balance of Planning Period FTR Auctions: Planning period 2012 to 2013	356
Figure 12-13 Ten largest positive and negative FTR target allocations summed by sink: Planning period 2012 to 2013	356
Figure 12-14 Ten largest positive and negative FTR target allocations summed by source: Planning period 2012 to 2013	356
Figure 12-15 FTR payout ratio with adjustments by month, excluding and including excess revenue distribution: January 2004 through December 2012	359
Figure 12-16 FTR Surplus and the collected Day-Ahead, Balancing and Total congestion: January 2005 through December 2012	363
Figure 12-17 FTR target allocation compared to sources of positive and negative congestion revenue	363
Figure 12-18 Annual FTR Auction prices vs. average day-ahead and real-time congestion for all control zones relative to the Western Hub: Planning period 2011 to 2012	370
APPENDIX A PJM GEOGRAPHY	373
Figure A-1 PJM's footprint and its 19 control zones	373
Figure A-2 PJM integration phases	374
Figure A-3 PJM locational deliverability areas	374
Figure A-4 PJM RPM EMAAC locational deliverability area, including PSEG North and DPL South	375
APPENDIX C ENERGY MARKET	379
Figure C-1 Hourly real-time LMP minus day-ahead LMP (On-peak hours): 2012	385
Figure C-2 Hourly real-time average LMP minus day-ahead average LMP (Off-peak hours): 2012	385

APPENDIX E INTERCHANGE TRANSACTIONS	403
Figure E-1 Con Edison and PSE&G wheel	410
APPENDIX F ANCILLARY SERVICE MARKETS	415
Figure F-1 PJM CPS1/BAAL performance: 2012	416
Figure F-2 DCS event count and PJM performance (By month): 2012	416
Figure F-3 PJM RegA signal and CReg compliance signal. Screenshot of typical 10-minute time period	418
Figure F-4 PJM RegD signal and CRegD compliance signal. Screenshot of typical 10-minute time period	418

