RPM as a Seasonal Construct: Motivation, Proposal, and Results of an Illustrative Simulation

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RPM as a Seasonal Construct (proposal #1 of 2)

1. Background and Motivation
2. Proposed Approach to RPM as a Seasonal Construct
3. Results of Illustrative Simulation
4. Summary: Potential Benefits

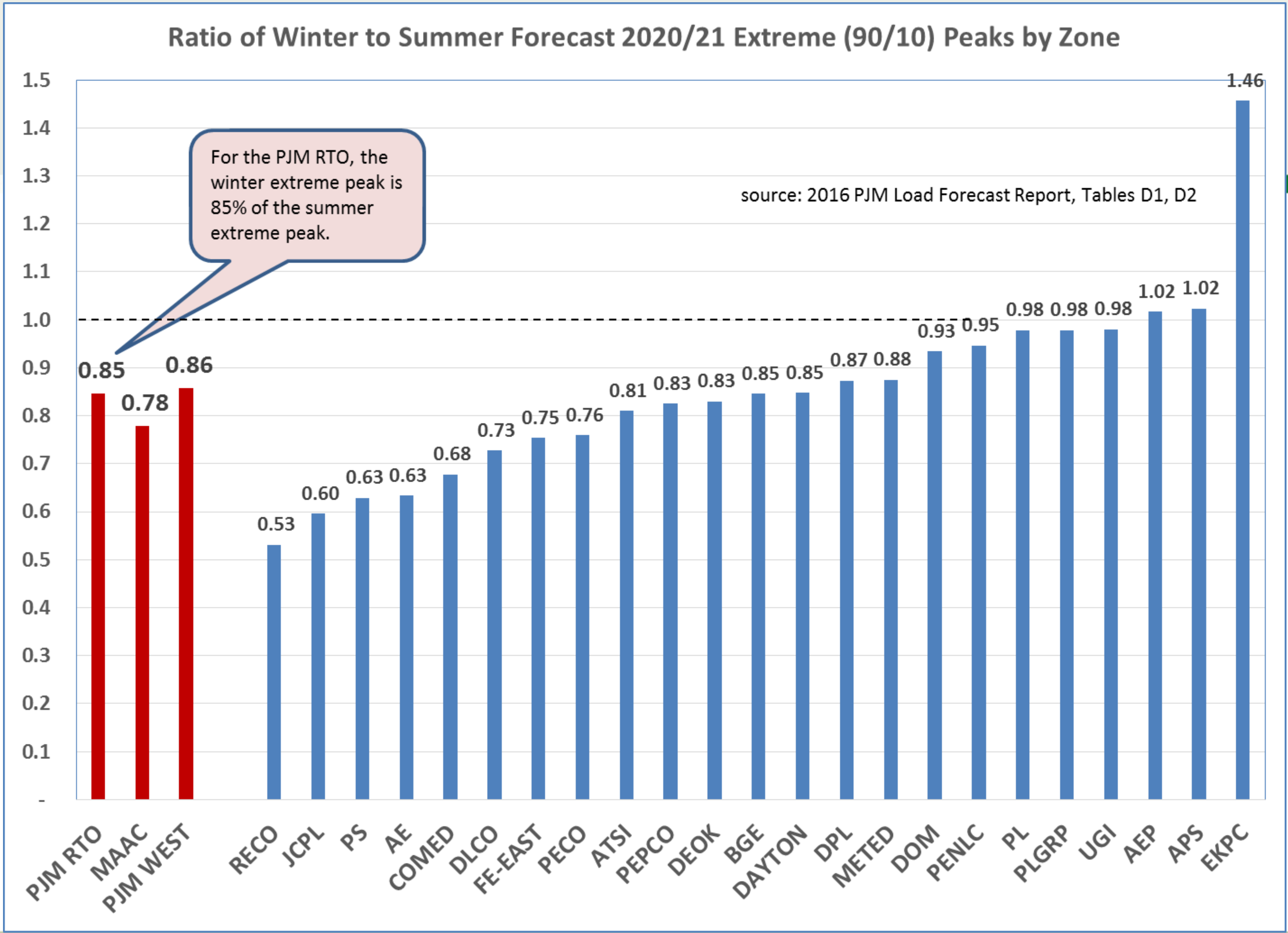
Appendix A: Additional details of the illustrative simulation

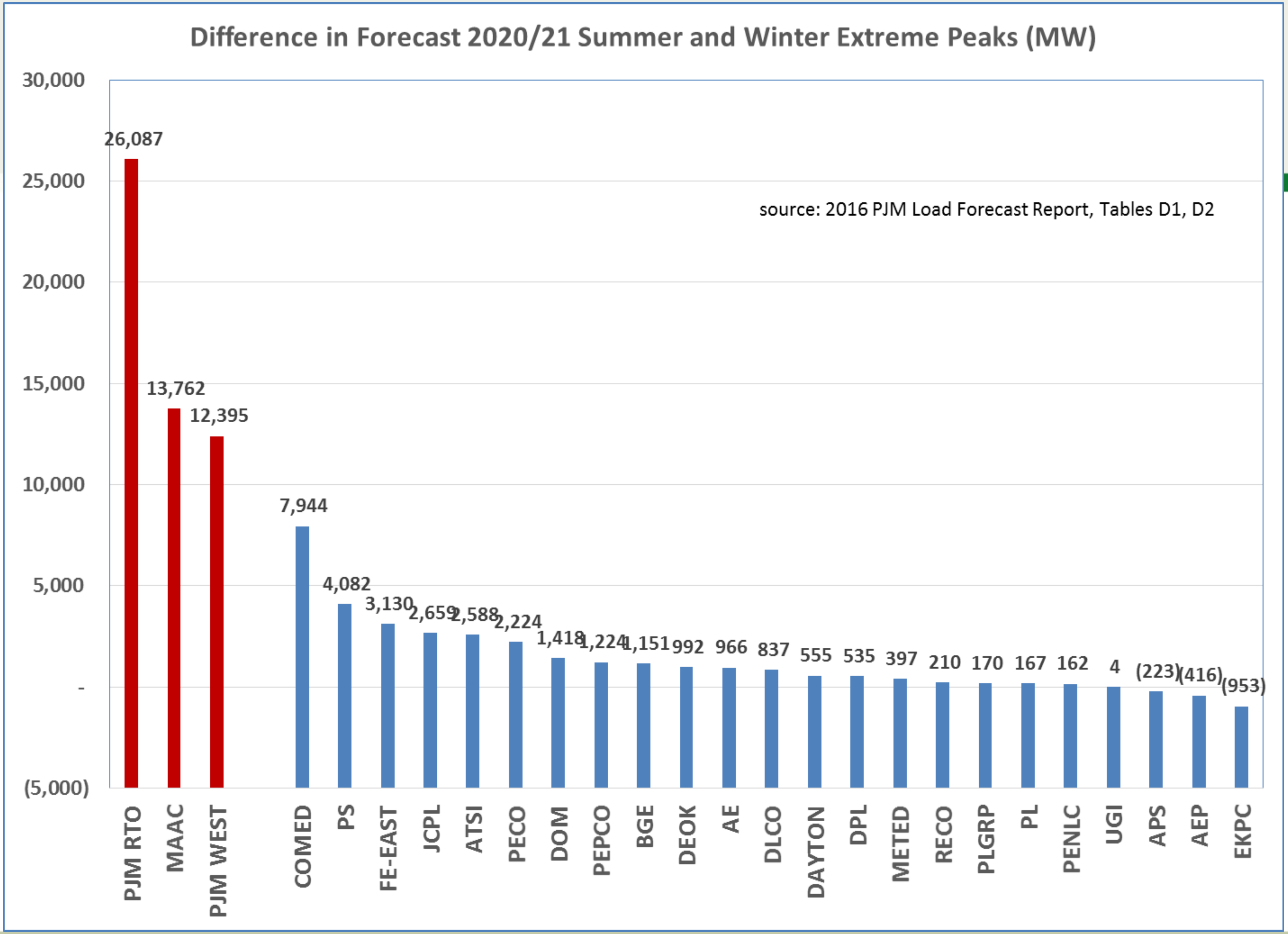
Appendix B: Planned and maintenance outage data

PJM Loads are Seasonal

- PJM RTO, and nearly all zones: Summer Peaking
  - Summer median (50/50) and summer “extreme” (90/10) peaks are well above the Winter 50/50 and 90/10 peaks
  - A few zones are winter peaking
  - Peaks in the Spring and Fall seasons are lower
  - This presentation focuses on the “extreme” (90/10) peaks, as these values, more than the 50/50 peaks, determine the amount of capacity for resource adequacy
  - *See: 2016 PJM Load Forecast Report, Tables B-1, B-2, D-1, D-2*

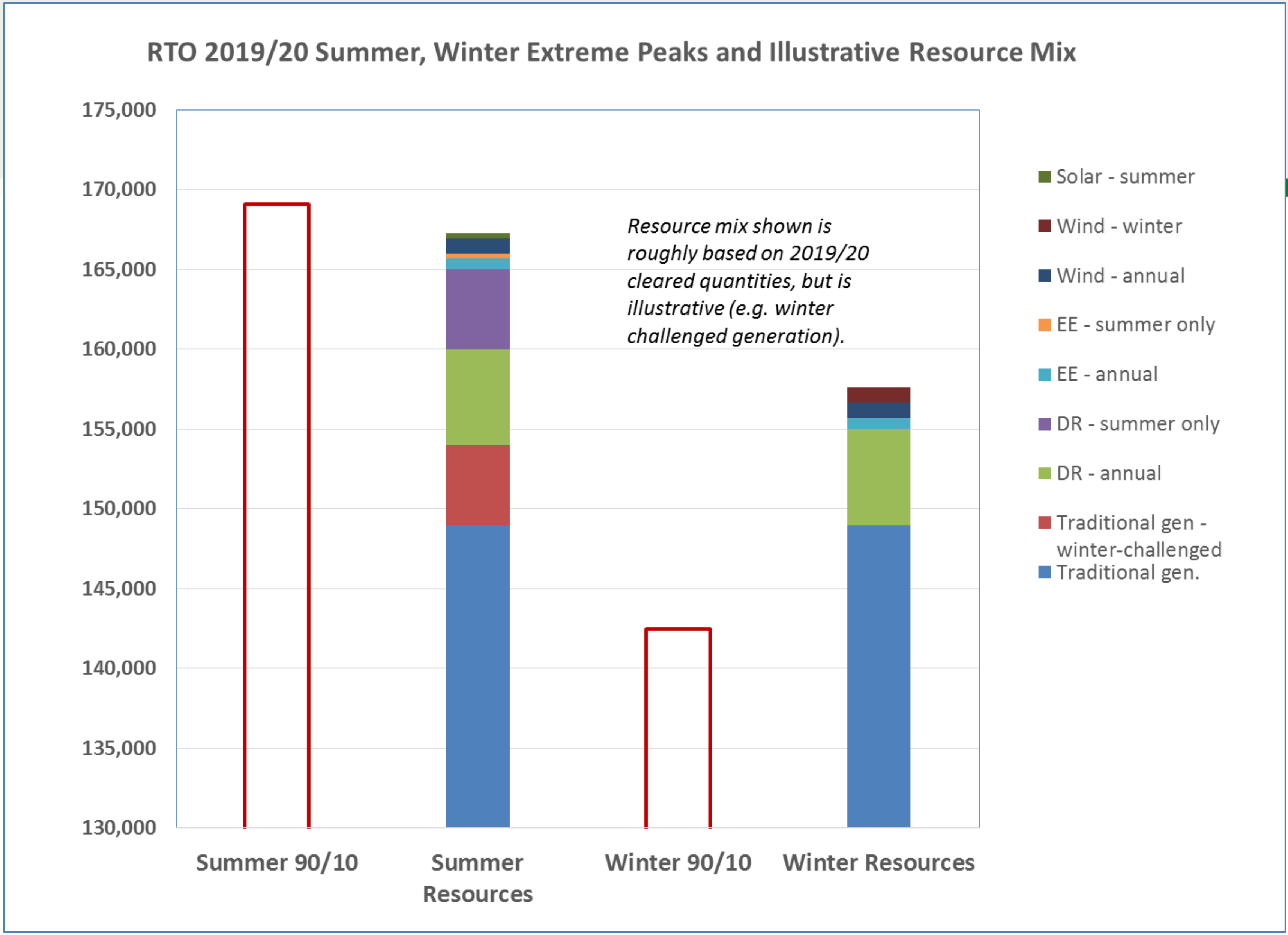
Resource adequacy: requires sufficient committed capacity all year (in all seasons)


Ratio of Winter to Summer Forecast 2020/21 Extreme (90/10) Peaks by Zone
For the PJM RTO, the winter extreme peak is 85% of the summer extreme peak.
source: 2016 PJM Load Forecast Report, Tables D1, D2
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
-
0.85
0.78
0.86
0.53
0.60
0.63
0.63
0.68
0.73
0.75
0.76
0.81
0.83
0.83
0.85
0.85
0.87
0.88
0.93
0.95
0.98
0.98
0.98
1.02
1.02
1.46
PJM RTO
MAAC
PJM WEST
RECO
JCPL
PS
AE
COMED
DLCO
FE-EAST
PECO
ATSI
PEPCO
DEOK
BGE
DAYTON
DPL
METED
DOM
PENLC
PL
PLGRP
UGI
AEP
APS
EKPC


Difference in Forecast 2020/21 Summer and Winter Extreme Peaks (MW)
source: 2016 PJM Load Forecast Report, Tables D1, D2
30,000
25,000
20,000
15,000
10,000
5,000
-
(5,000)
PJM RTO 26,087
MAAC 13,762
PJM WEST 12,395
COMED 7,944
PS 4,082
FE-EAST 3,130
JCPL 2,659
ATSI 2,588
PECO 2,224
DOM 1,418
PEPCO 1,224
BGE 1,151
DEOK 992
AE 966
DLCO 837
DAYTON 555
DPL 535
METED 397
RECO 210
PLGRP 170
PL 167
PENLC 162
UGI 4
APS (223)
AEP (416)
EKPC (953)

PJM Resource Mix and Capacity Value: The Seasonal Aspect Has Become More Important

- Many years through 2013: RRS Study says all LOLE in summer, large excess in winter; little perceived value in winter availability, winterization…….
- More recently:
  - Polar vortex wake-up call on value of winter capacity
  - Increasing penetration of inherently seasonal resources: demand response, gas-fired generation with winter fuel challenges, energy efficiency, wind, solar
- Seasonal price signals are valuable to guide decisions about seasonal resources and service


RTO 2019/20 Summer, Winter Extreme Peaks and Illustrative Resource Mix
175,000
170,000
165,000
160,000
155,000
150,000
145,000
140,000
135,000
130,000
Resource mix shown is roughly based on 2019/20 cleared quantities, but is illustrative (e.g. winter challenged generation).
Summer 90/10
Summer Resources
Winter 90/10
Winter Resources
Solar - summer
Wind - winter
Wind - annual
EE - summer only
EE - annual
DR - summer only
DR - annual
Traditional gen - winter-challenged
Traditional gen.

2. RPM as a Seasonal Construct: Proposed Approach

- Two seasons, each with a separate Reliability Requirement for RPM:
  - "Summer": Months of June through October plus May
  - "Winter": Months of November through April (seasons as proposed by PJM)
- In RPM base residual auctions, use two sloped demand curves to acquire capacity to meet the two seasonal requirements
- Most resources likely submit "Annual" offers with no seasonal aspect
- All resources permitted to reflect seasonality in their offers
  - Seasonal ratings (UCAP – unforced capacity)
  - Seasonal costs and risks – minimum summer, winter prices
  - Subject to must-offer requirement and offer price caps

Seasonal Capacity MW Reliability Requirements: Proposed Approach (other approaches possible)

- PJM bases resource adequacy on the “One Day in Ten Years” criterion (also known as Loss of Load Expectation, or LOLE, = 0.10)
- Proposed approach: LOLE allocated 90%/10% to summer/winter
  - Summer requirement based on LOLE 0.09, Winter requirement uses LOLE 0.01
  - Winter requirement also reflects higher levels of outages
- Result of proposed approach for RTO:
  - Summer Reliability Requirement is slightly greater than Annual requirement (+ ~ 500 MW) due to the slightly lower LOLE target
  - Winter Reliability Requirement TBD. Perhaps 15,000 MW or more lower.
- Zones: Analogous approach can be used (allocate LOLE 90%/10%)

Other RPM Design Elements That Could Be Adapted

A seasonal construct creates an opportunity (but in most cases not a necessity) to revisit various other RPM features.

- Likely elements to reconsider:
  - Seasonal UCAP ratings
  - Seasonal penalties and stop loss
- Could revisit other RPM features, such as:
  - VRR curve parameters (especially Net CONE) for Winter season
  - Cost allocation

3. Illustrative Simulation of a Seasonal RPM Construct

- Scope:
  - Simulate results for an Annual-Only construct with aggregation, to compare to seasonal proposals
  - Use illustrative assumptions roughly based on the most recent RPM auction
  - RTO only (zones not modeled)
- Goals:
  - Illustrate potential impact of seasonal approaches (cleared quantities, prices, reliability, cost, etc.) under one set of realistic assumptions
  - Rough idea of potential impacts and benefits relative to Annual-Only
  - Identify key drivers; surface issues about how a seasonal construct might work
  - <u>Not</u> intended to be predictive!

Results of Illustrative Simulation: Annual Only w/Aggregation

	Ann. Only
Clearing price *	$ 148.0
Cleared quantity	165,605
% of Rel. Req't	105.4%
LOLE	0.016
Total cost ($ bil.)	$ 9.2
Trad. Gen	157,105
DR	6,000
EE	700
Wind	800
Wind/DR agg.	1,000
Solar	0

Observations:

- Supply curve assumptions determine $148/MW-day clearing price – not a predicted value
- Assumed 1,000 MW of Wind/DR aggregation
- Further details of simulation are in Appendix

Disclaimer: <u>Illustrative</u> assumptions and results – alternative, reasonable assumptions might give very different results!

Results of Illustrative Simulation: Seasonal Construct

	Ann. Only	Sum.	Win.	Sum +Win
Clearing price *	$ 148.0	$ 104.8	$ 31.2	$ 136.0
Cleared quantity	165,605	167,668	154,076	
% of Rel. Req't	105.4%	106.4%	108.1%	
LOLE	**0.016**	0.010	0.001	**0.011**
Total cost ($ bil.)	**$ 9.2**			**$ 8.2**
Trad. Gen	157,105	154,518	145,576	
DR	6,000	10,000	6,000	
EE	700	1,000	700	
Wind	800	800	800	
Wind/DR agg.	1,000	1,000	1,000	
Solar	0	350	0	

* Note: seasonal prices assumed paid 365 days; so summer and winter prices are additive; annual resources earn the sum.

Observations:

- Winter price roughly ¼ Summer price; reflects assumptions about generation offers for winter service
- Sum of Summer + Winter prices lower than Annual Only mainly due to accommodation of seasonal resources (DR, EE, Solar, gen.)
- Some generation clears summer-only
- Seasonal results in better reliability, lower cost; overall savings in this illustrative simulation: $1 bil./year

Disclaimer: <u>Illustrative</u> assumptions and results – alternative, reasonable assumptions might give very different results!

Seasonal Construct: Price Signals; Price Formation Expectations

	Annual Only	Seasonal Construct
Price signal for Annual resources	B.R.A. price (Net CONE concept applies)	Summer price plus Winter price (Net CONE concept applies)
Price signal for incremental Summer capacity	No summer or winter price signals *(aggregation may be understood to create a price signal that is not transparent, and also not consistent with incremental summer, winter reliability value)*	Explicit price signal: likely reflects incremental annual value (Net CONE concept) net of anticipated net winter value
Price signal for incremental Winter capacity		Explicit price signal: price required to entice sufficient annual resources to provide winter service

4. Seasonal RPM Construct: Summary of Potential Benefits

- Better accommodates participation by resources with seasonal differences
- Allows tailoring capacity quantity to seasonal needs (which are much lower in Winter for RTO, MAAC, nearly all zones)
- Creates separate price signals for incremental summer, winter MW
- More efficient: results in higher reliability at lower total cost (cost savings result from accommodating seasonal resources, tailoring winter capacity quantity to actual need)
- Can be combined with other SCRSTF proposals (M&V, aggreg.)
- More consistent with seasonal capacity constructs in neighboring regions (NYISO, MISO (proposed), IESO (proposed))

Appendix A:
Additional details of the illustrative simulation

Illustrative Simulation Assumptions: Seasons, Requirements, VRR curves

- Assumptions based on 2019/20 base residual auction parameters
  - Reliability Requirement, VRR curve shape, Net CONE
- Summer (June-October plus May): Reliability Requirement = Annual Reliability Requirement + 500 MW
  - Consistent with LOLE = 0.09 (PJM RRS report)
- Winter (November through April): Reliability Requirement = Summer Requirement – 15,000 MW (value used for simulation purposes)
  - Conservative assumption, allows for much more outage time in winter
  - Cleared quantities >> Rel. Req't due to use of annual VRR curve for winter
  - *(FYI: summer extreme peak – winter extreme peak approx. 26,000 MW)*

Illustrative Simulation Assumptions: Resources, Offers

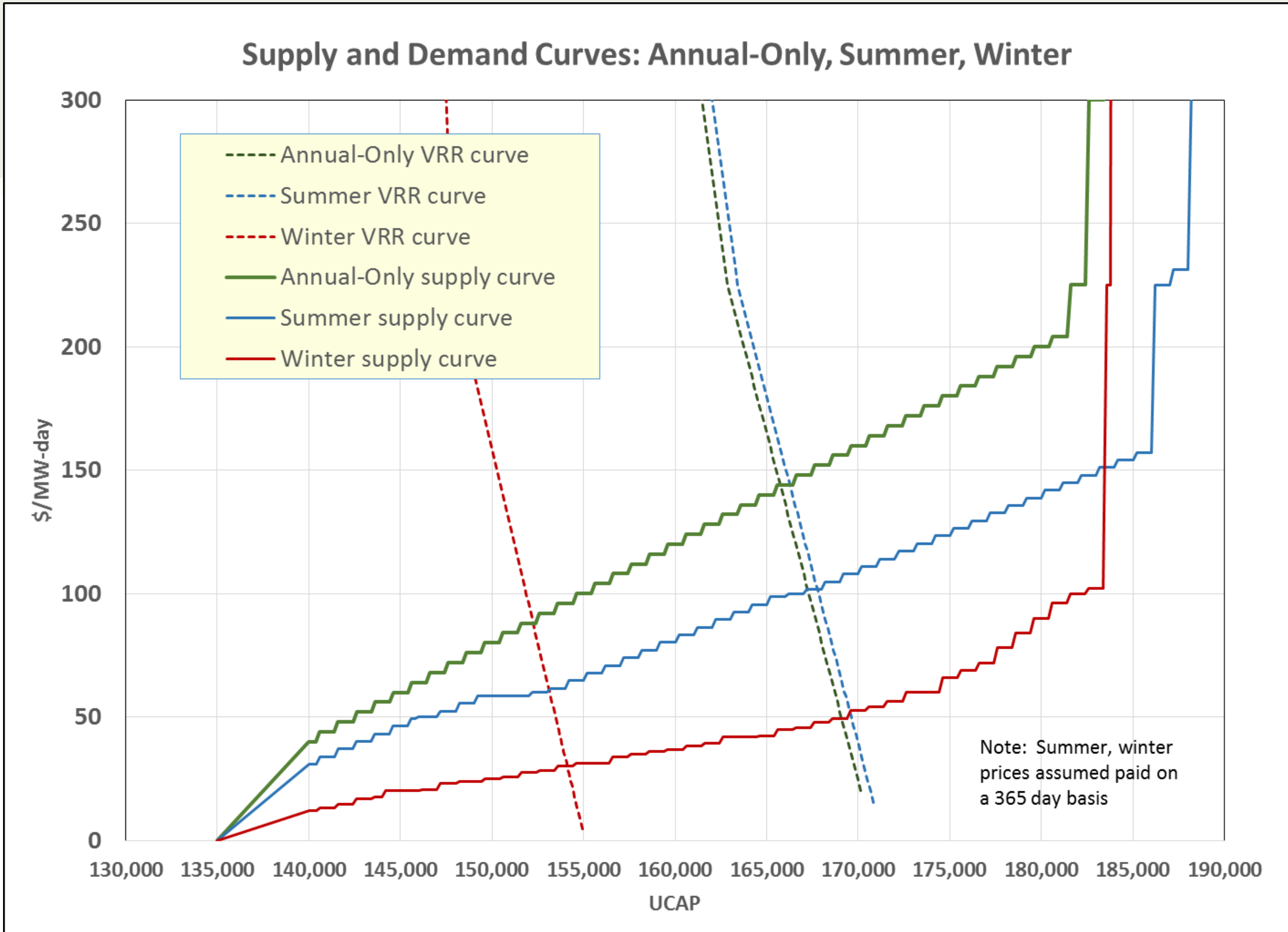
- Roughly based on quantities from 2019/20 base residual auction
- Five resource categories: Wind, Solar, EE, DR, Traditional generation
- *Seasonal* offers: separate offer prices for Summer and Winter; used to reflect seasonal availability of wind, solar, EE, DR (details below)
- *Annual* offers: single annual offer price; resource clears if offer is at or below sum of seasonal clearing prices
- Offer *quantities* not varied by season or offer type (prices control clearing)
- Note: for Summer and Winter seasons, offer and clearing prices expressed as $/MW-day but assumed paid 365 days (not just during performance period)
  - So $120/MW-day Summer price + $30/MW-day Winter price = $150/MW-day Annual

Resource Assumptions: Traditional Generation Category

- Supply curve based on slope of $4 per 1,000 MW
  - somewhat gentler than in 2018/19 auction (last available sensitivity analysis)
- Traditional generation make "Annual" offers with Winter minimum
  - Clear as Annual if sum of summer and winter prices exceeds annual offer price and winter price exceeds winter minimum price
  - Clear as summer-only if summer price exceeds annual offer price, and winter price falls short of winter minimum price
- Assumption about generation winter minimum offers drives winter clearing price
  - Assumption used: 1/3 offer @ 10% of Annual offer price, 1/3 @ 30%, 1/3 @ 50%

Resource Assumptions:
Other Resource Types (Offered MW UCAP)

	FYI: 2019/2020 Actual Cleared		Annual-Only	Summer	Winter
	Total	As CP			
Demand Response	10,348	614	6,000	11,000	6,000
Energy Efficiency	1,515	1,058	700	1,000	700
Wind	969	89	800	800	1800
Wind/DR aggr.			1000		
Solar	335	0	0	350	0


Supply and Demand Curves: Annual-Only, Summer, Winter
300
250
200
150
100
50
0
$/MW-day
Annual-Only VRR curve
Summer VRR curve
Winter VRR curve
Annual-Only supply curve
Summer supply curve
Winter supply curve
Note: Summer, winter prices assumed paid on a 365 day basis
130,000
135,000
140,000
145,000
150,000
155,000
160,000
165,000
170,000
175,000
180,000
185,000
190,000
UCAP

Appendix B:
Planned and maintenance outage information

Figure 5-9 PJM equivalent outage and availability factors: 2007 to 2015

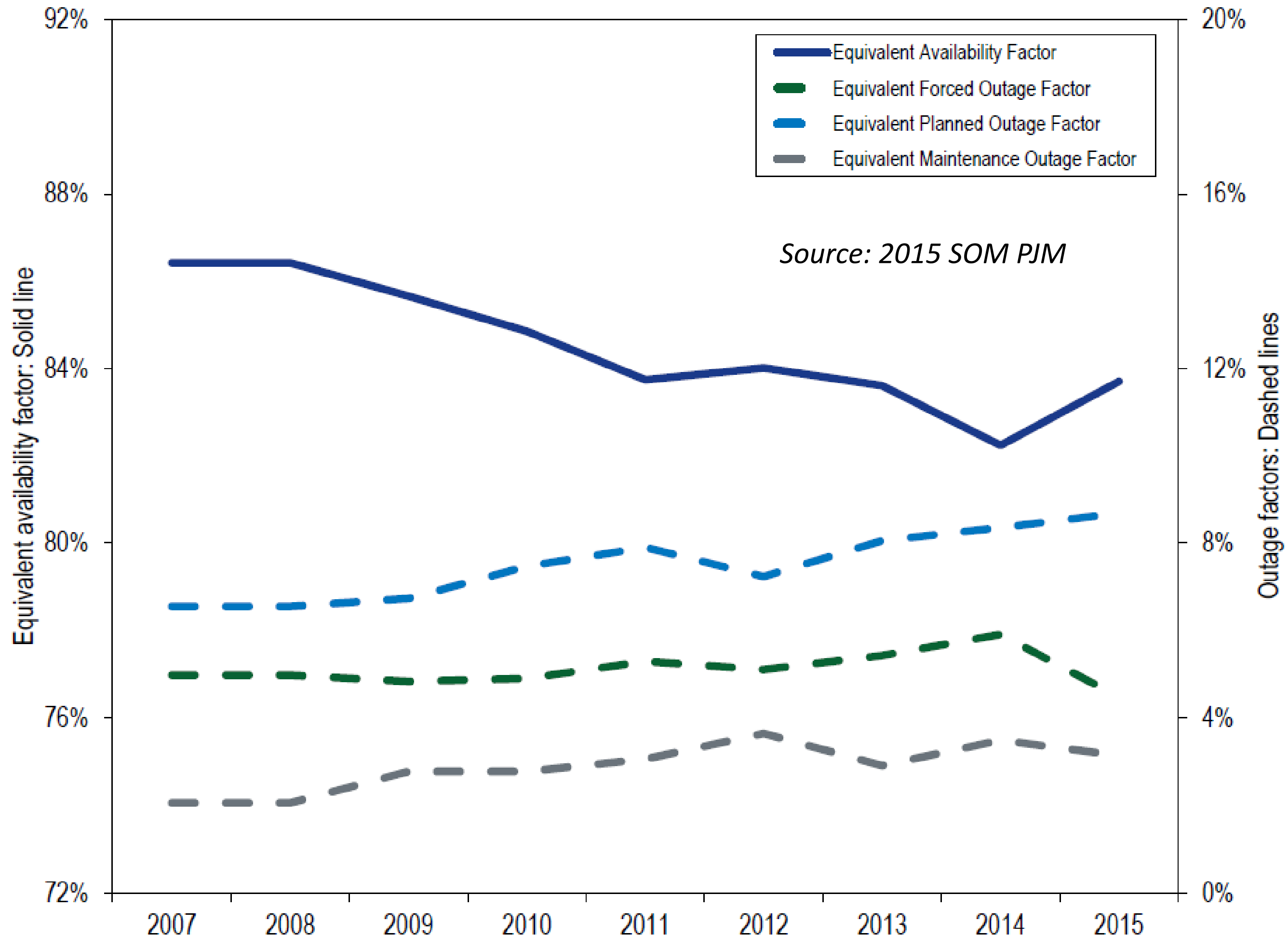
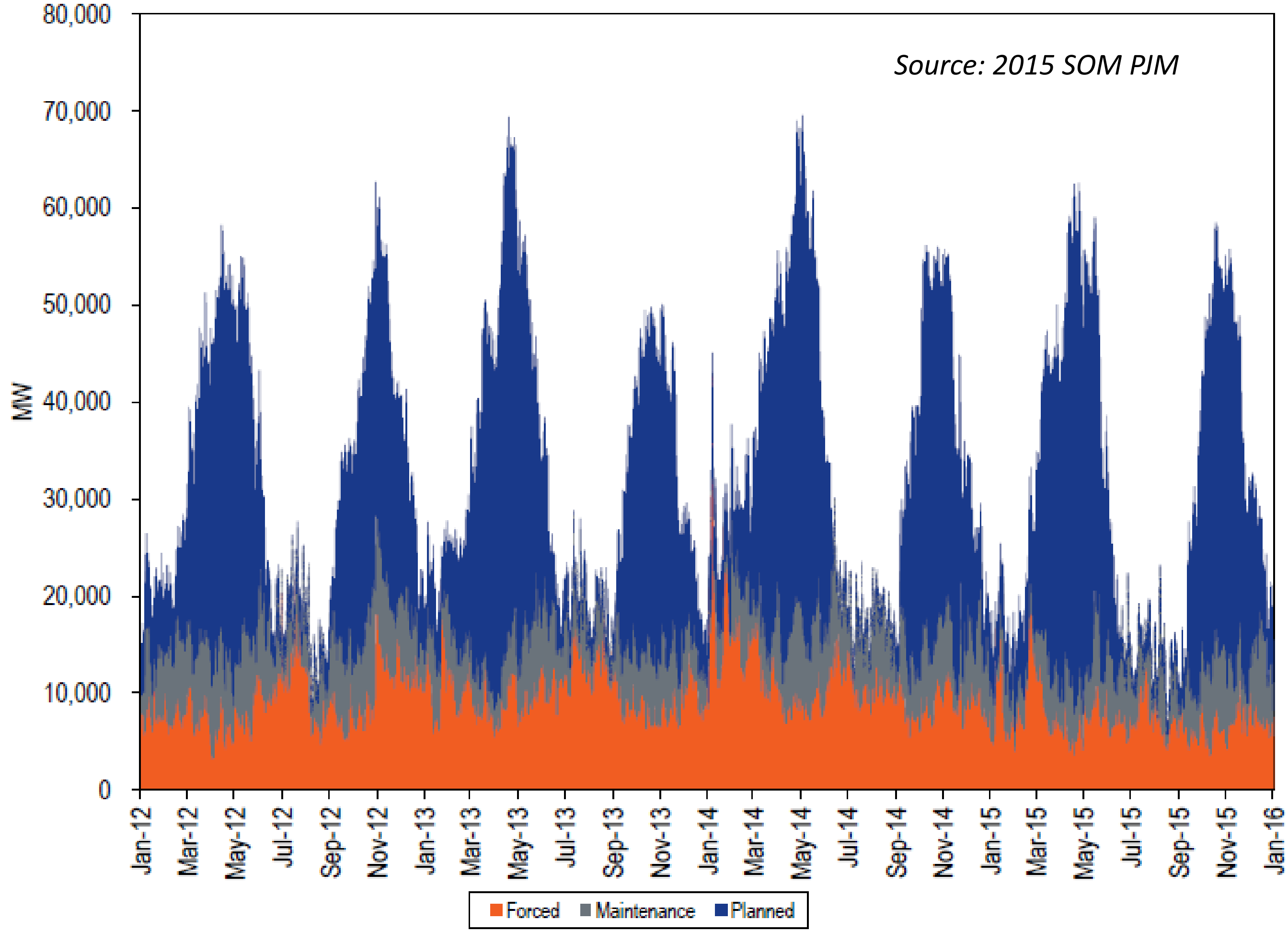
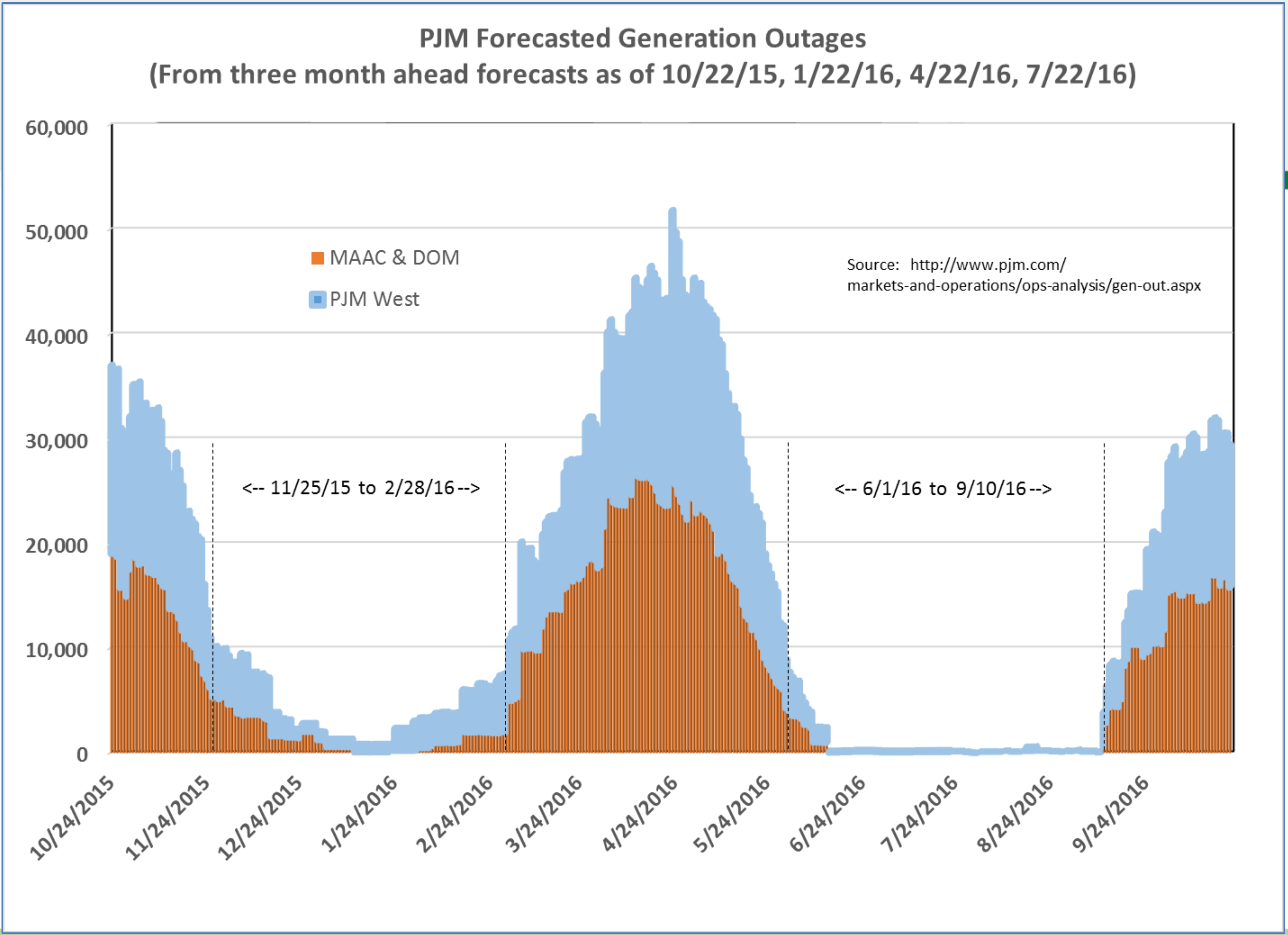


Figure 5-8 PJM outages (MW): 2012 through December 2015




PJM Forecasted Generation Outages
(From three month ahead forecasts as of 10/22/15, 1/22/16, 4/22/16, 7/22/16)
60,000
50,000
40,000
30,000
20,000
10,000
0
MAAC & DOM
PJM West
Source: http://www.pjm.com/
markets-and-operations/ops-analysis/gen-out.aspx
<-- 11/25/15 to 2/28/16 -->
<-- 6/1/16 to 9/10/16 -->
10/24/2015
11/24/2015
12/24/2015
1/24/2016
2/24/2016
3/24/2016
4/24/2016
5/24/2016
6/24/2016
7/24/2016
8/24/2016
9/24/2016