

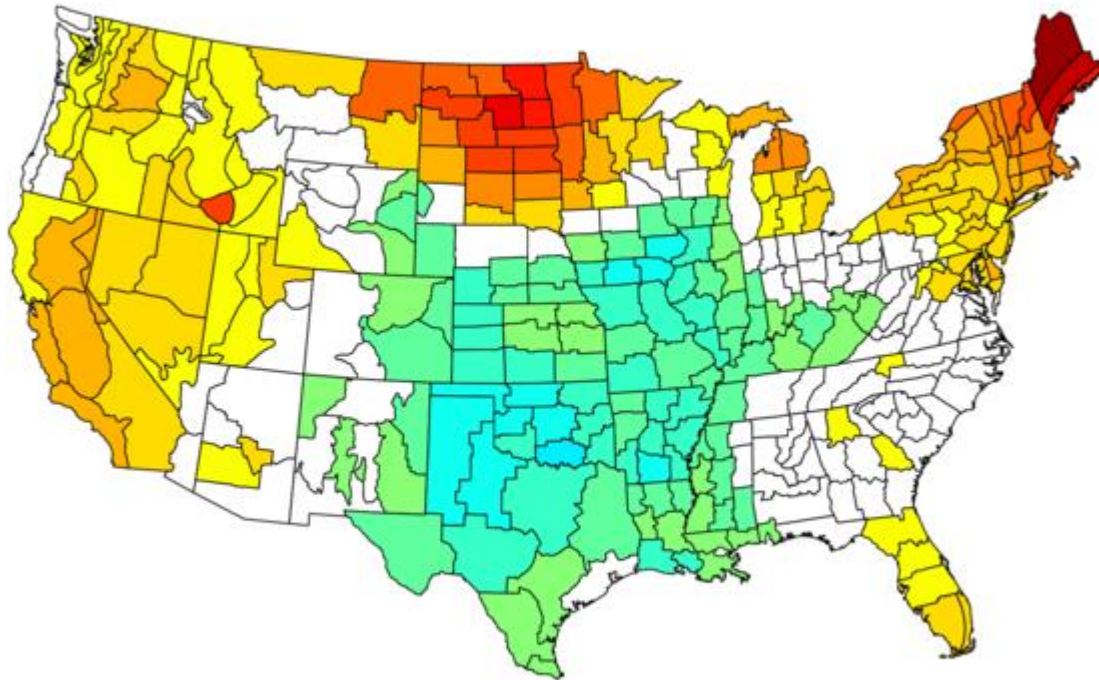


# Winter Operations of the PJM Grid: December 1, 2020 – February 28, 2021

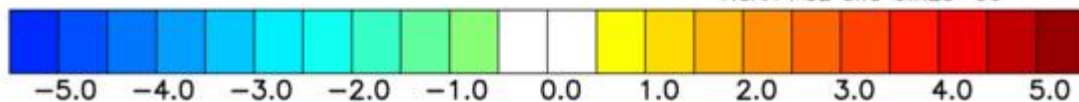
Operating Committee  
April 8, 2021

# Winter 2020/21 Overview

NOAA/NCEI Climate Division Temperature Anomalies (F)  
Dec to Feb 2020–21  
Versus 1981–2010 Longterm Average



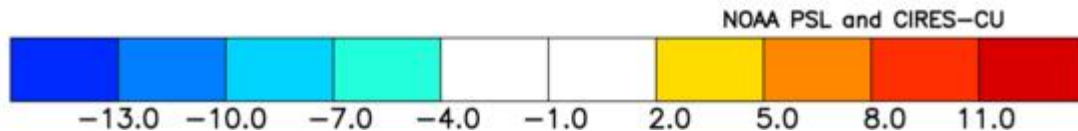
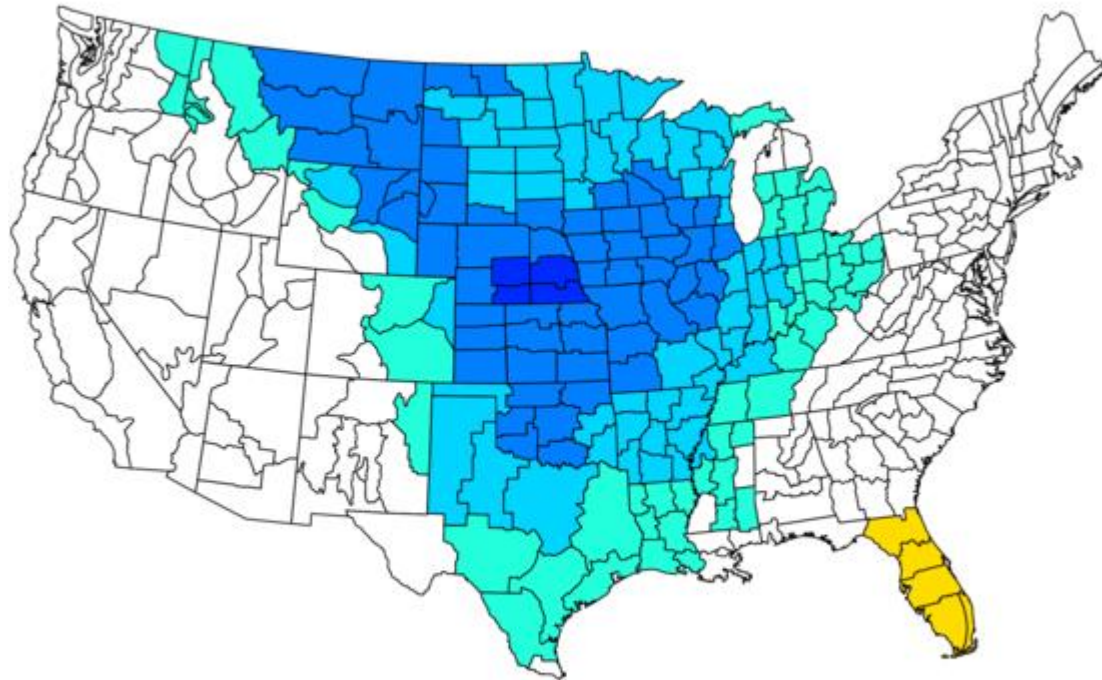
NOAA PSL and CIRES-CU



Source: <https://www.esrl.noaa.gov>

- For most of the RTO footprint, temperatures were at or slightly above average over the entire winter.
- Temperatures in the RTO's western zones, however, were below average for the season.

NOAA/NCEI Climate Division Temperature Anomalies (F)  
Feb 2021  
Versus 1981–2010 Longterm Average

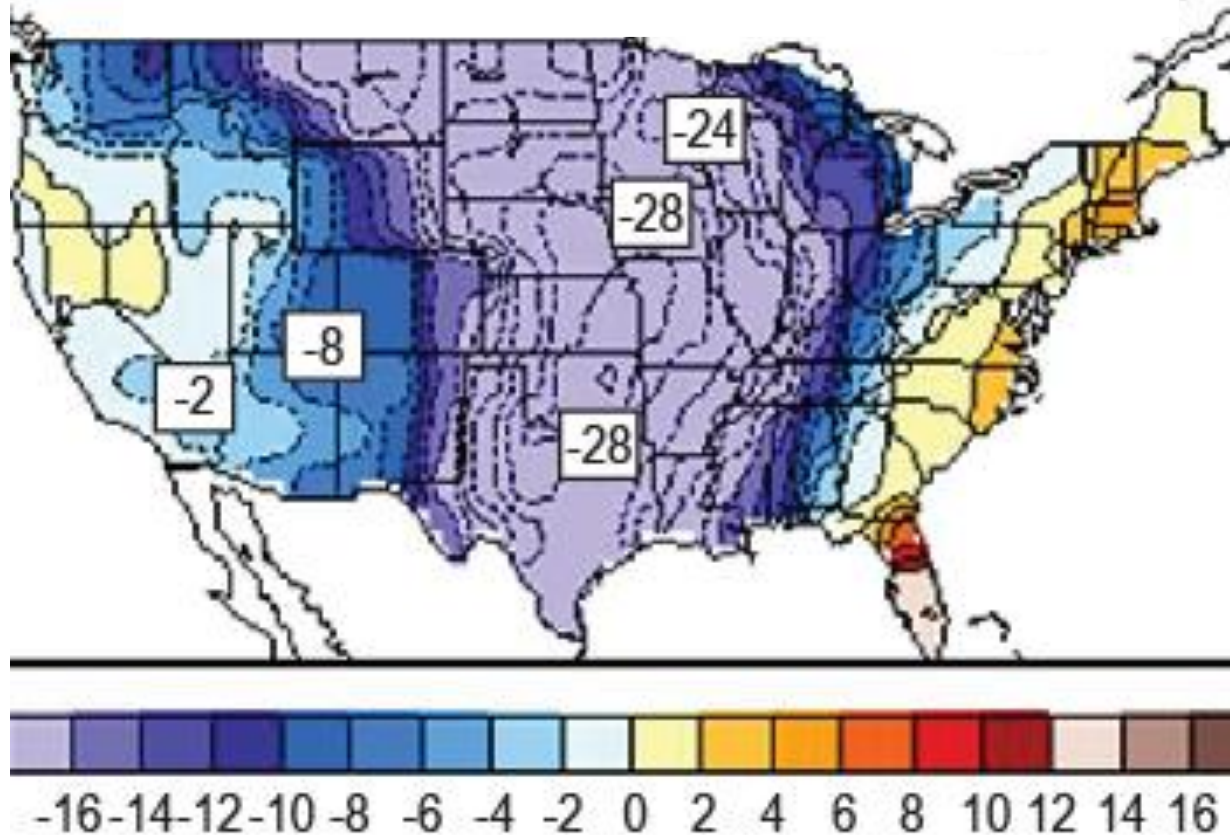


Source: <https://www.esrl.noaa.gov>

- During February, temperatures were very close to normal in the eastern part of the RTO and well below normal in the western zones.
- Four Cold Weather Alerts were issued this winter – all occurring in February.



# Average Low Temperatures Feb. 15 – Feb 19



- During President's day week, the Midwest faced low temperatures that were as much as 28 degrees below their normal lows.
- Most of PJM's footprint was spared such extreme cold weather, experiencing lows much closer to normal.

Source: [https://www.cpc.ncep.noaa.gov/products/tanal/temp\\_analyses.php](https://www.cpc.ncep.noaa.gov/products/tanal/temp_analyses.php)

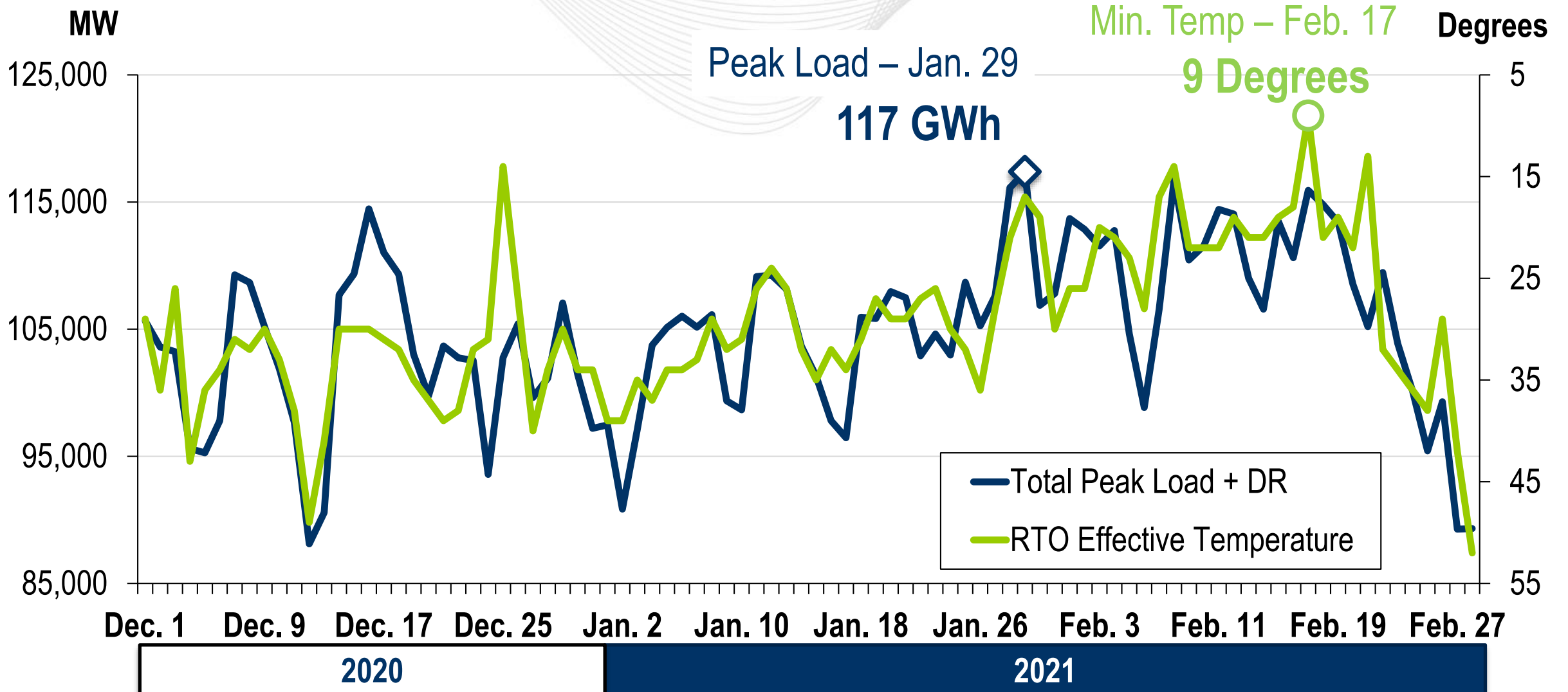
Zone	Start	End
AEP, AMPT, COMED, CPP, DAY, DEOK, DUQ, FE-AP, FE-ATSI, ITCI, OVEC	2/7/21 6:00	2/8/21 23:59
COMED	2/9/21 0:00	2/10/21 23:59
COMED	2/14/21 0:00	2/14/21 23:59
WESTERN	2/15/21 0:00	2/15/21 23:59

- Cold Weather Alerts occurred primarily in the western zones
- Only two of the Cold Weather Alerts coincided with the cold weather experienced during the week of President’s Day.

- There is a strong relationship, a correlation of approximately 75%, between load and effective temperature, a measure similar to wind chill that takes into account wind speed and its chilling effect.
- In the winter, as temperatures go down, the load goes up (and vice versa), exhibiting a strong, inverse relationship.
- The following slide plots effective temperatures from high to low, rather than the traditional low to high, to show the close tracking between load and effective temperature.



# Daily RTO Peak Load and Effective Temperature



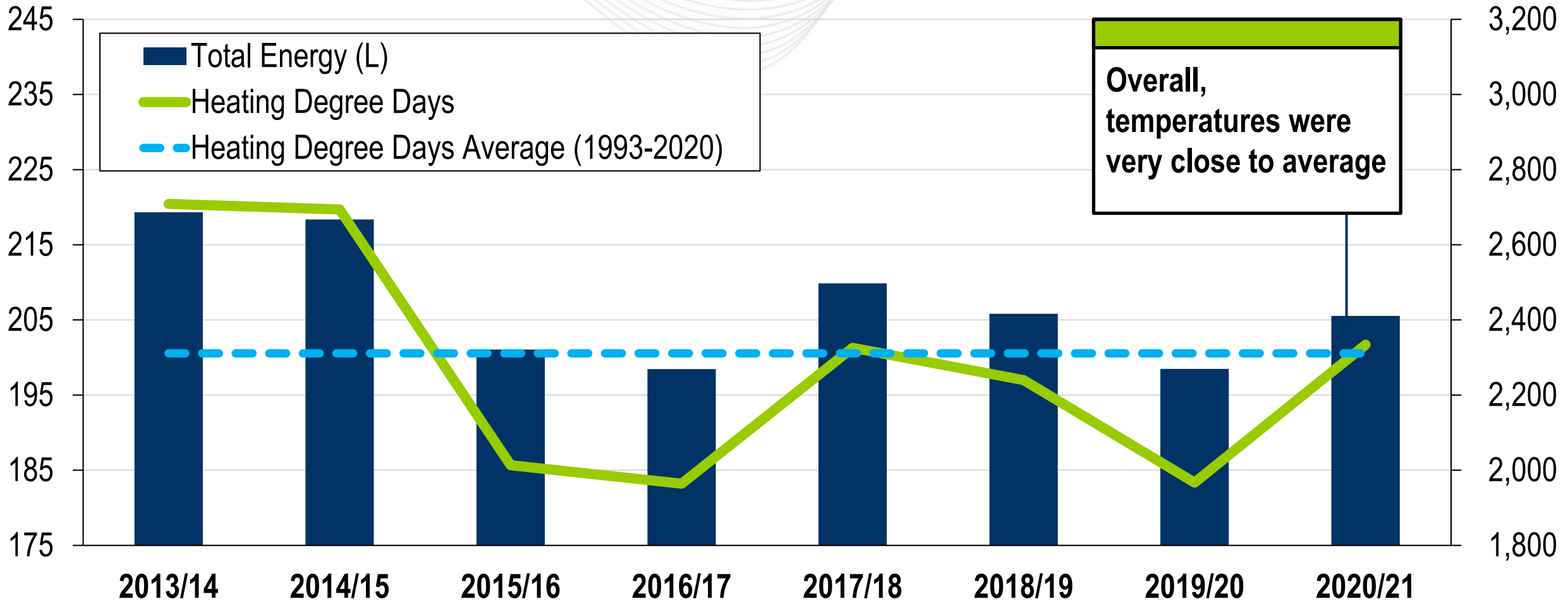


- The following slide shows the historic relationship between heating degree days and total energy.
- Heating degree days measure the temperature's cumulative deviation from a base point, in this case 60 degrees, over a specified time period.
- While heating degree days in 2020/21 overall are very close to the historical average, total energy was dampened, most likely due to on-going impacts of COVID-19.
- February was the only month this winter to experience above average heating degree days or total energy.

# Historic Total Energy and Heating Degree Days

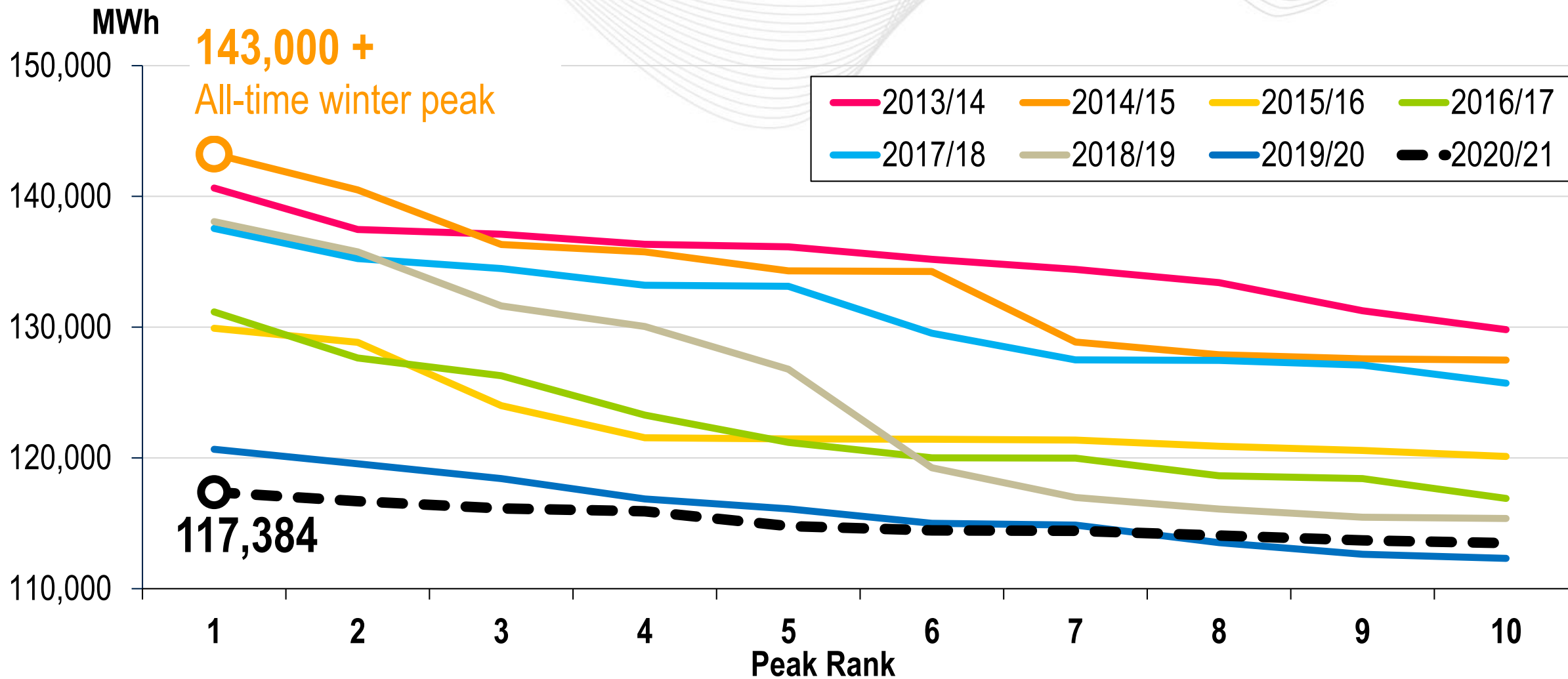
GWh (Thousands)

Heating Degree Days



- The following slides show the top 10 winter peaks for 2020/21 and all recent winters including 2013/14 (Polar Vortex, pink line) and 2014/15 (all time winter peak, orange line), respectively.
- Peaks were dampened this winter, most likely due to the on-going impacts of COVID-19.
- The highest peak this winter was lower than the 10<sup>th</sup> highest peak in most other winters.

Peak Rank	Date	Hour Ending	Peak
1	Friday, January 29, 2021	9	117,384
2	Monday, February 08, 2021	9	116,686
3	Thursday, January 28, 2021	19	116,130
4	Wednesday, February 17, 2021	8	115,912
5	Thursday, February 18, 2021	11	114,785
6	Wednesday, December 16, 2020	18	114,452
7	Thursday, February 11, 2021	19	114,421
8	Friday, February 12, 2021	10	114,061
9	Monday, February 01, 2021	19	113,696
10	Monday, February 15, 2021	19	113,485

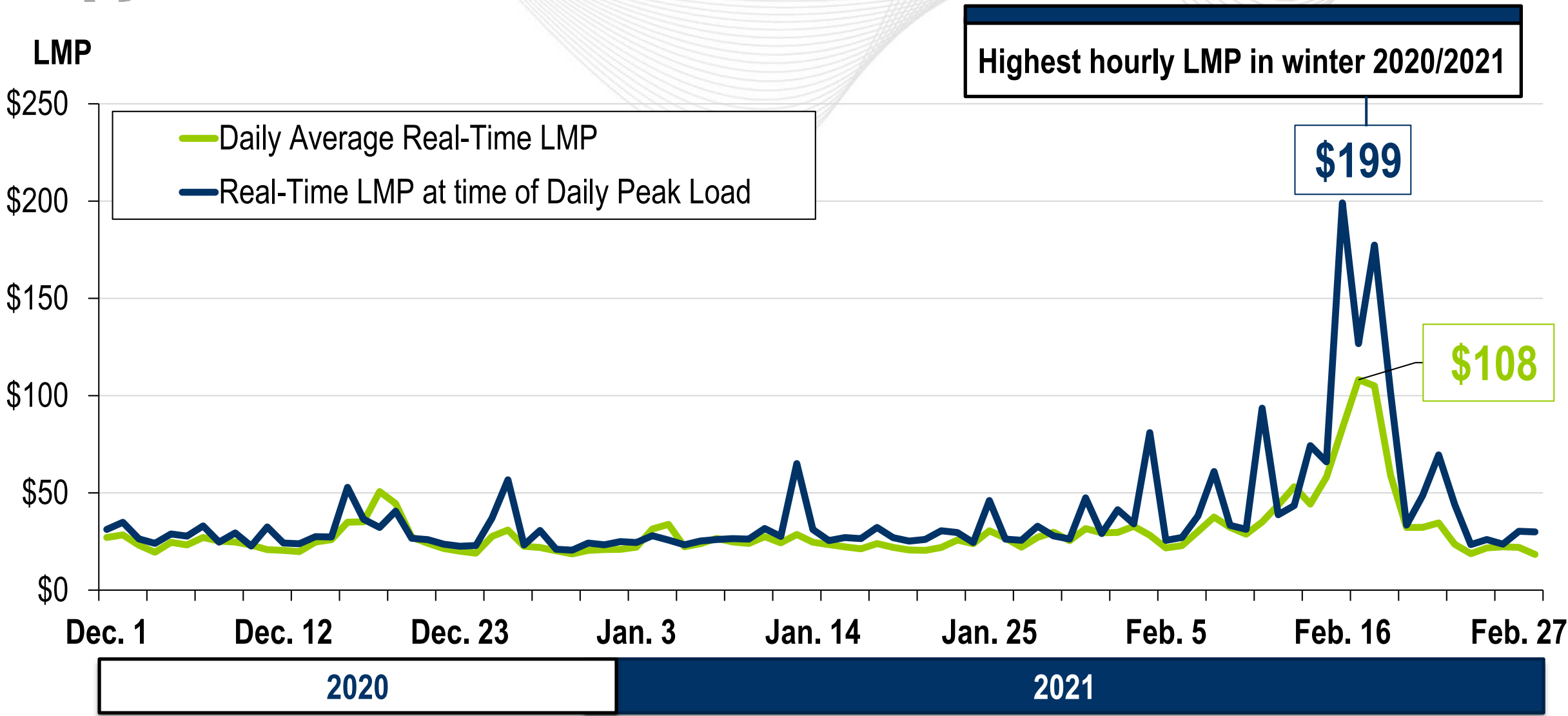


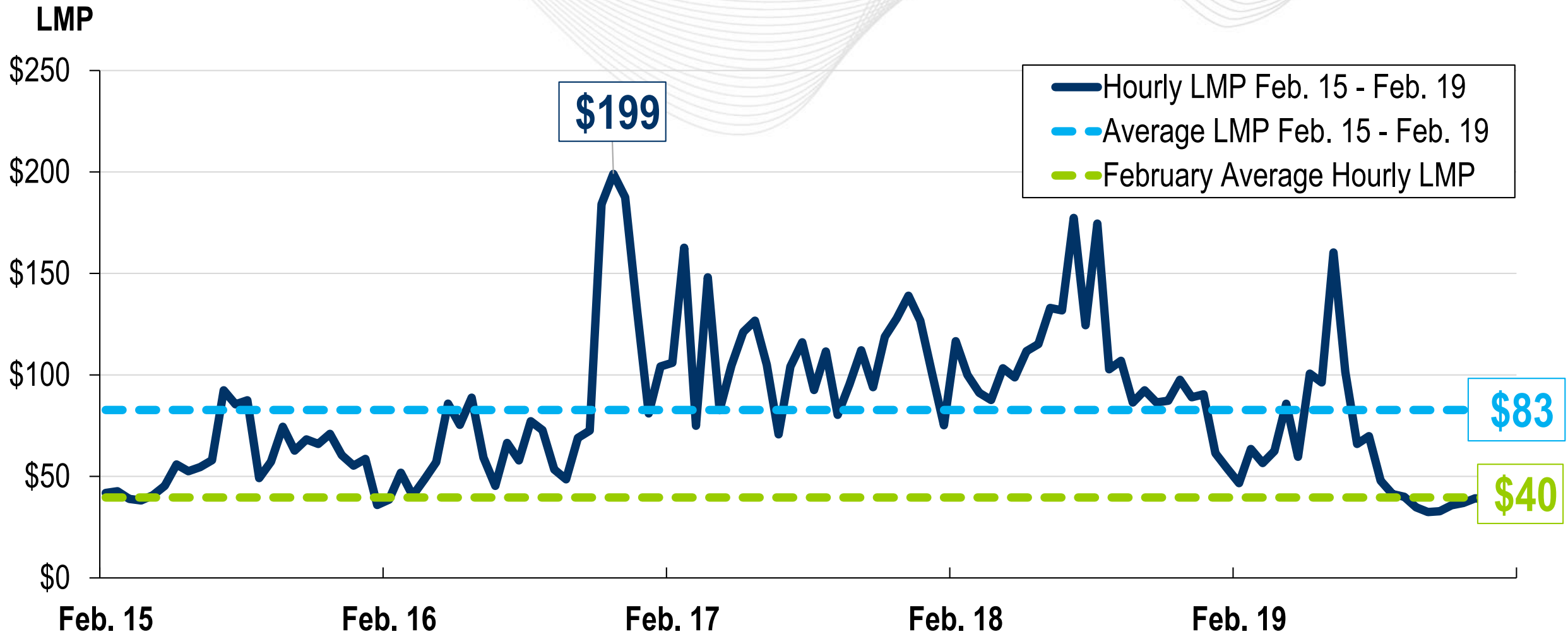


- The following three slides show the daily average LMP and the LMP at the time of the daily load peak, hourly LMPs for President's Day week, and the historic monthly average LMPs, respectively.
- LMPs in December and January were in line with those experienced in recent winters.
- The highest daily average LMP value was \$108 and no single hour in the winter of 2020/21 had an LMP value exceeding \$200.
- LMPs for February averaged approximately \$40, while the average for the winter as a whole was just under \$30.



# Daily Average and Peak Real Time LMPs

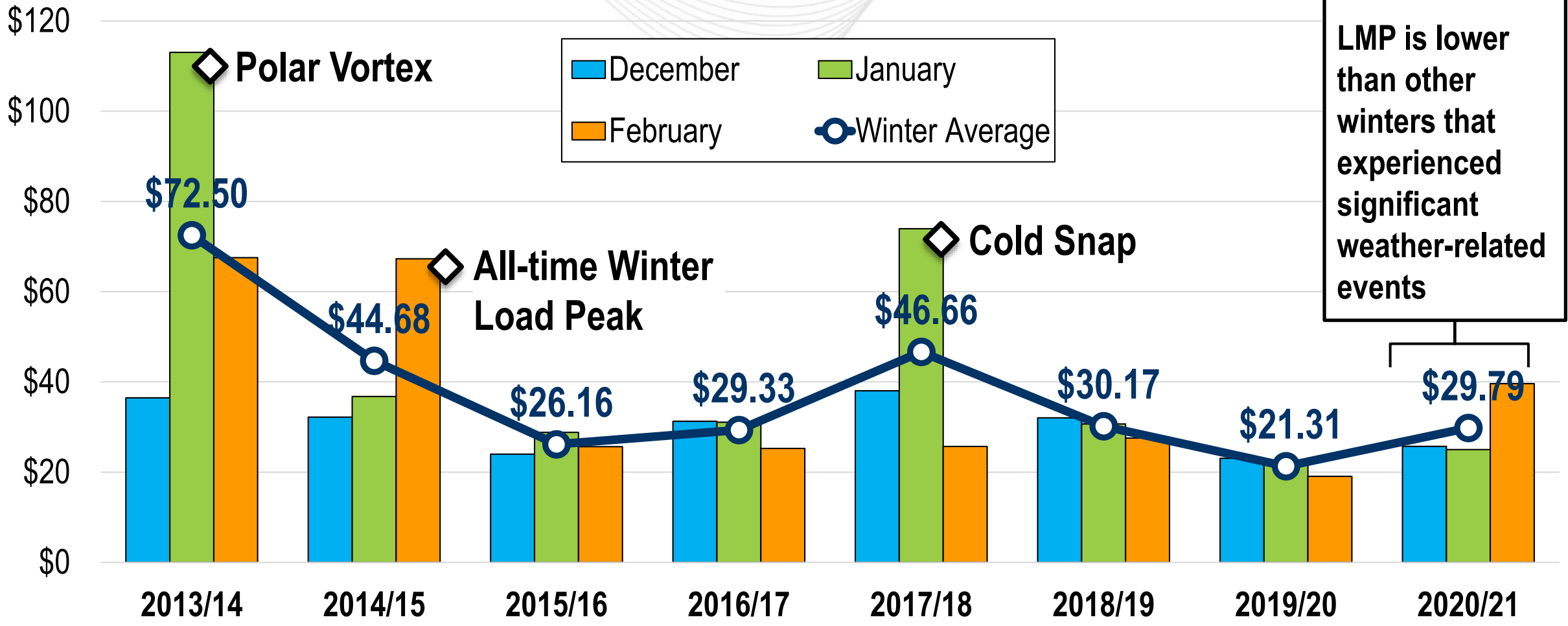




2021

# Historic Winter Average Real Time LMPs

## Average LMP



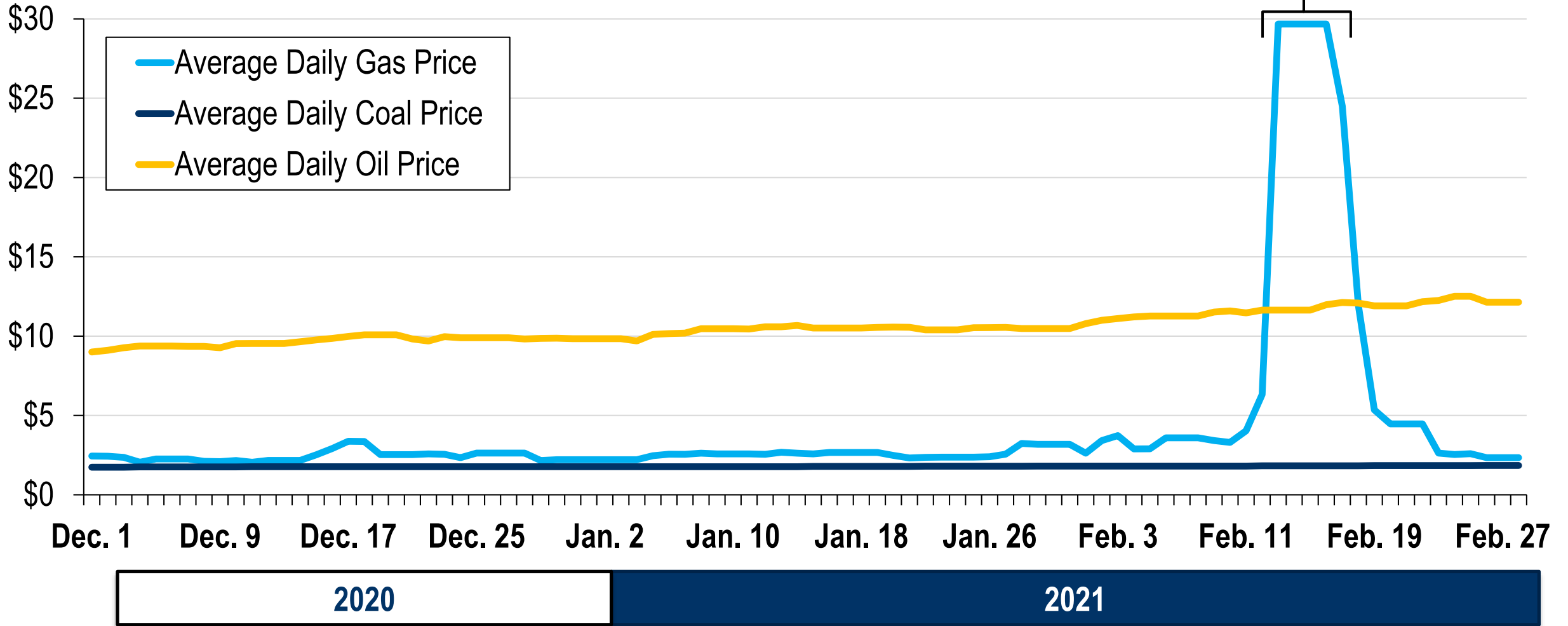
LMP is lower than other winters that experienced significant weather-related events

- The following two slides show the daily average fuel prices as well as the daily average fuel prices and daily average LMPs for February 2021, indexed to their monthly averages, respectively.
- These fuel prices are straight averages of a selection of representative fuel pricing hubs in PJM's footprint. Averages are not load weighted, nor are they meant to represent the price that any particular market participant may have experienced.
- At their peaks, average daily gas prices and LMPs exceeded their average monthly values by approximately 360% and 270%, respectively.

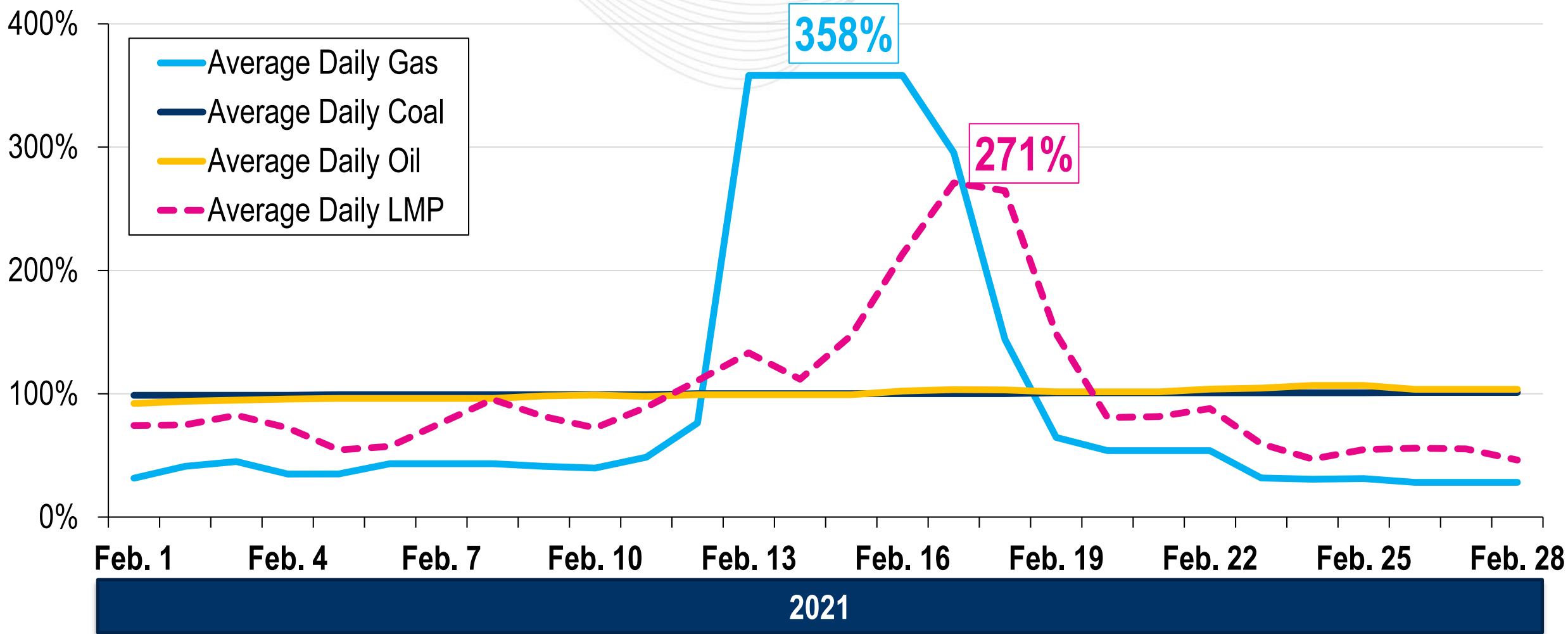


\$/mmbtu

**Four-day holiday weekend gas package**



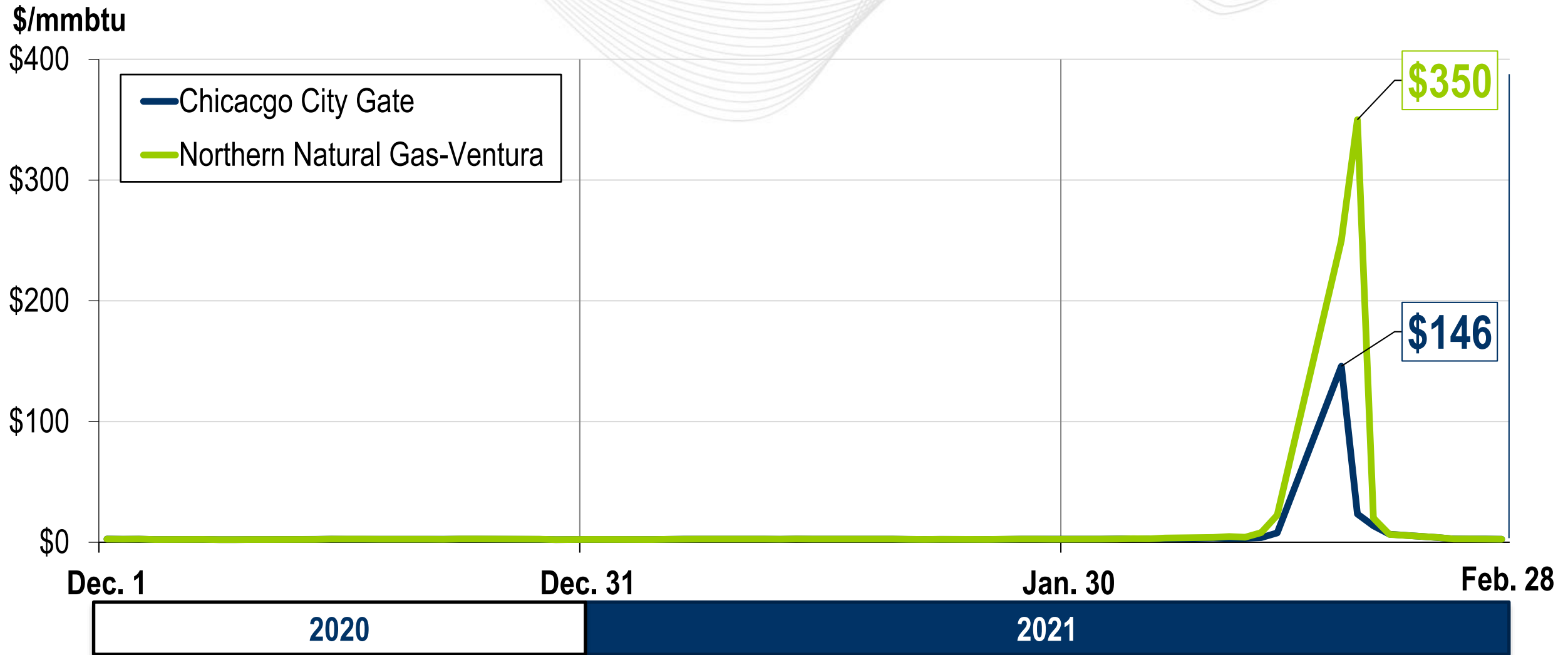
# Deviation From February 2021 Average Price



- The following two slides show daily maximum spot prices for natural gas at select hubs in both western and eastern parts of the PJM footprint.
- In the COMED region, prices at the Ventura hub reached \$350/mmbtu at their peak, while prices at hubs in the east only reached between \$15 – \$20/mmbtu.
- High natural gas prices led to some cost-based offers exceeding \$1,000/MWh, triggering PJM's offer verification process. However, no units with \$1,000+ offers were picked up in the Day Ahead or Real Time markets.

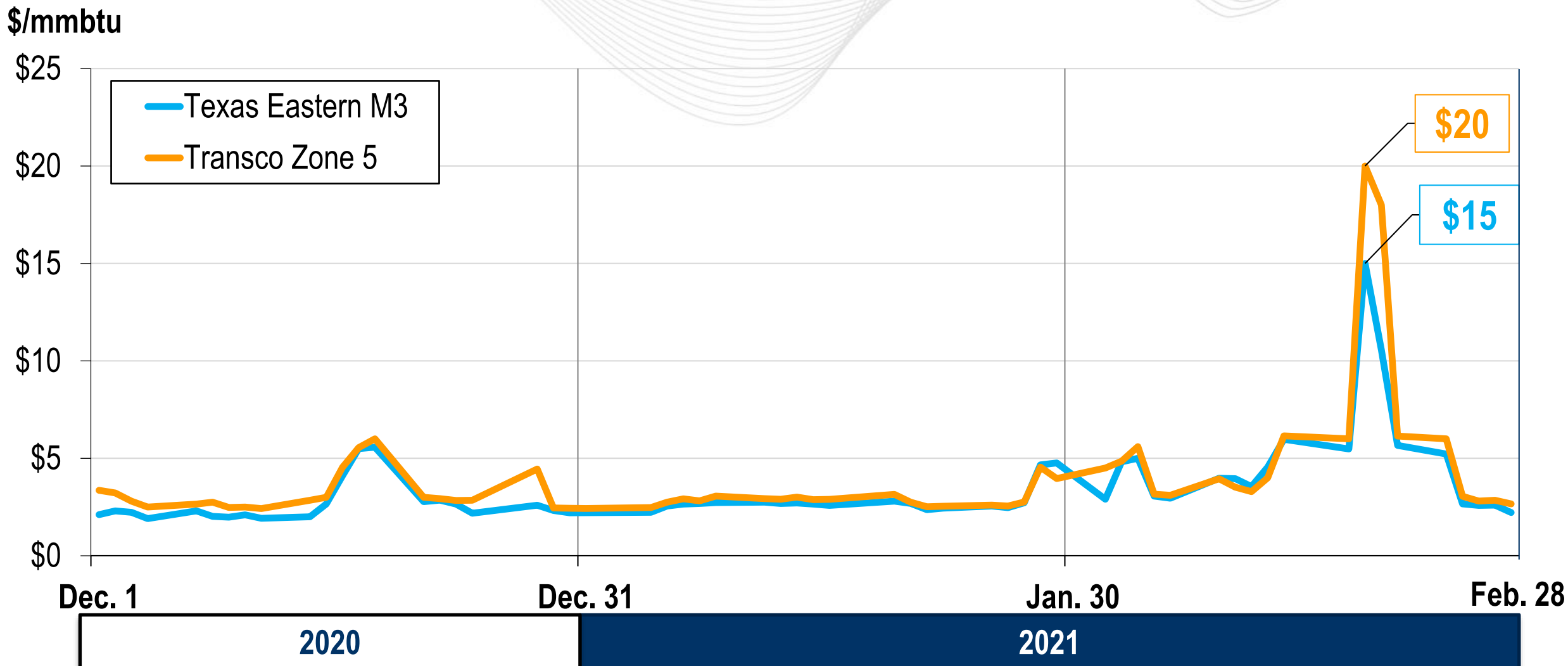


# Maximum Daily Natural Gas Prices – Western PJM Gas Hubs



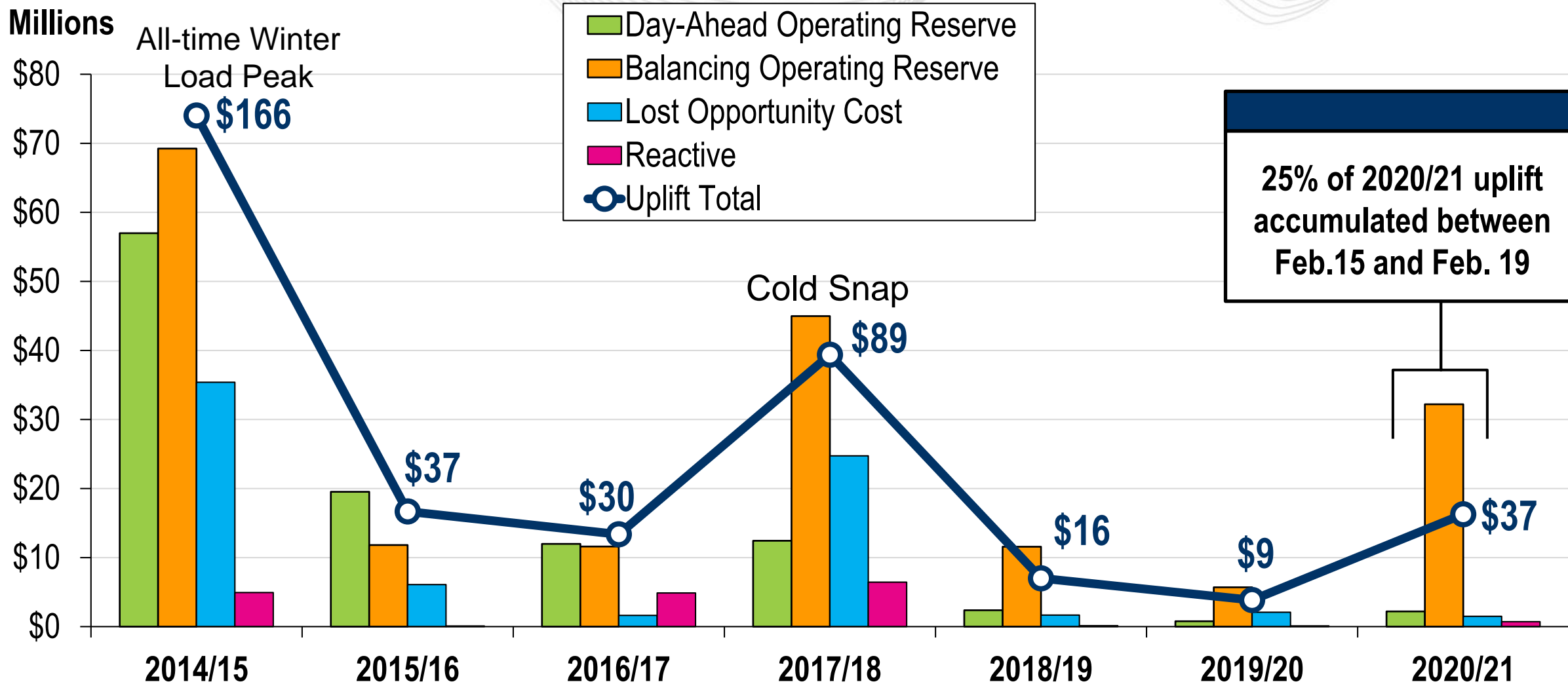


# Maximum Daily Natural Gas Prices – Eastern PJM Gas Hubs

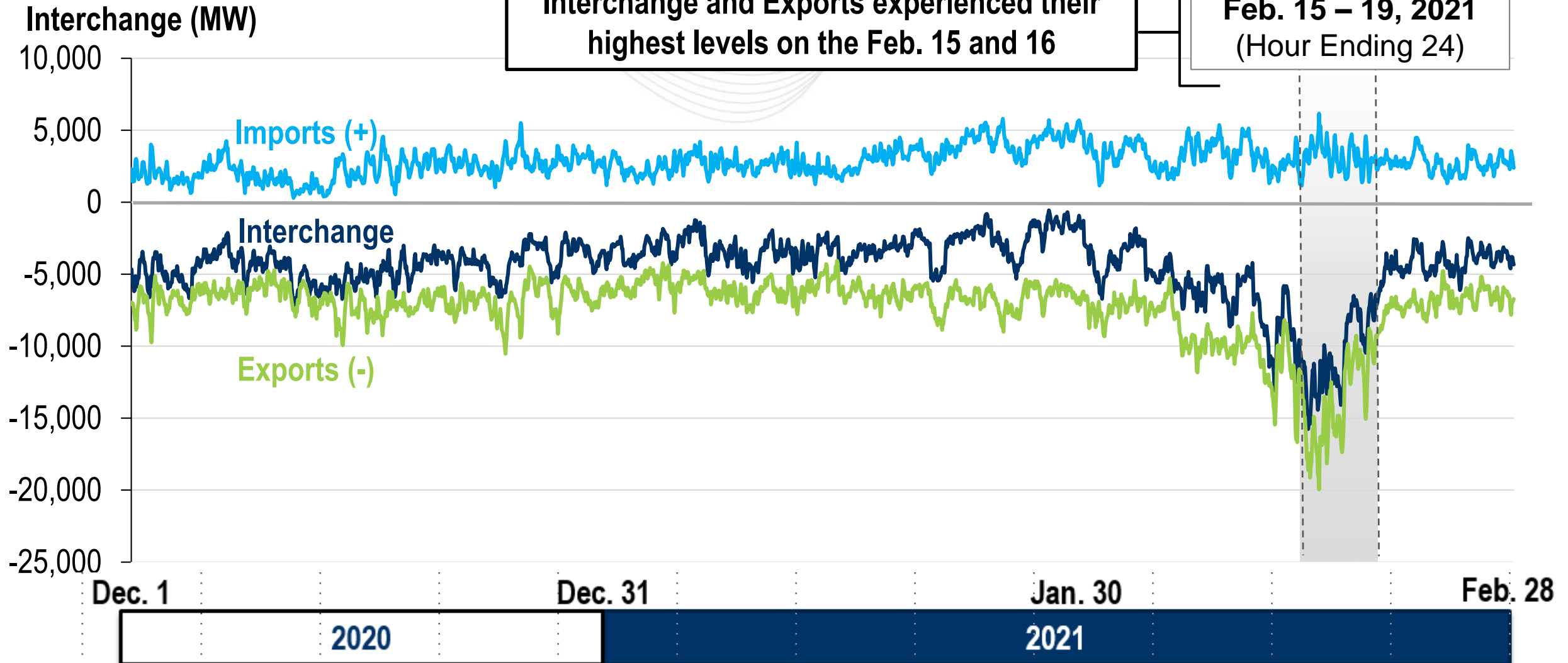




- The following slide shows uplift for the past seven winters.
- 2013/14, the winter of the Polar Vortex, is not shown on this graph because the magnitude of uplift that year was significantly higher than any subsequent year. Uplift totaled over \$750 million that winter.
- Of the \$36.6M of uplift in winter of 2020/21, \$9.4M (25.7%) was accumulated between Feb.15 and Feb.19.
- Over \$4.9M (13%) of all uplift this winter, is attributable to units running at the direct request of a TO for localized reliability. This uplift will be allocated directly to the requesting TO.



# Operations



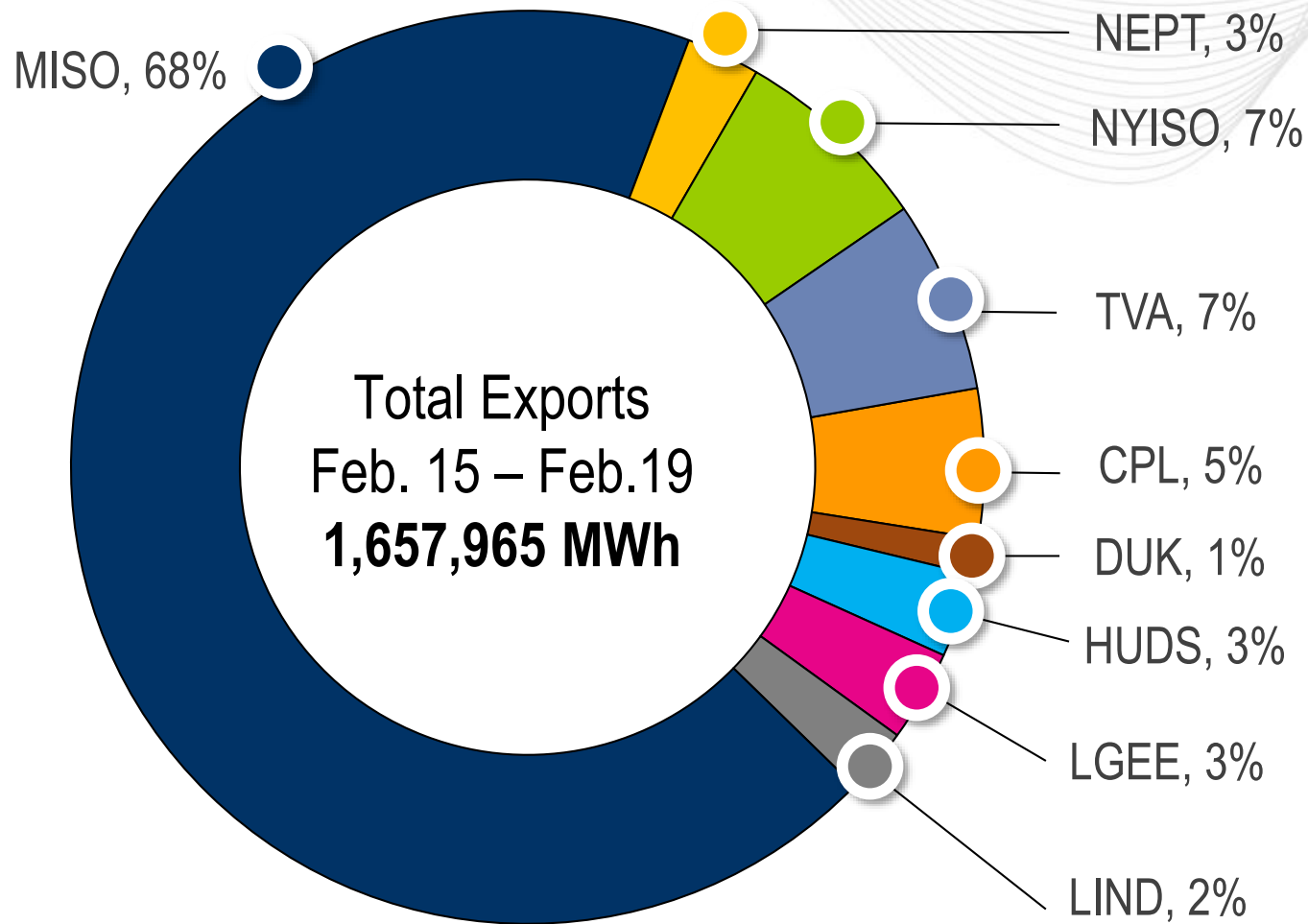
- During the cold weather experienced throughout President's Day week, PJM had unprecedented interchange. During the top-10 peak interchange hours, interchange was more than three times higher than the 2020/21 winter average.
- During the top-10 peak interchange hours, PJM was exporting more than five times as many MW as it was importing.
- During the top-10 peak interchange hours, exports were 2.5 times higher than the 2020/21 winter average.
- Imports during the top-10 peak interchange hours were very similar to the 2020/21 winter average.





# Top 10 Interchange Hours – Winter 2020/21

Rank	Date	Hour Ending	Total Interchange	Total Exports	Total Imports
1	Monday, February 15, 2021	15	-15,763	-18,607	2,844
2	Monday, February 15, 2021	18	-15,394	-19,128	3,734
3	Monday, February 15, 2021	16	-15,169	-17,842	2,673
4	Monday, February 15, 2021	14	-14,999	-17,822	2,823
5	Monday, February 15, 2021	13	-14,733	-17,817	3,084
6	Monday, February 15, 2021	17	-14,632	-17,467	2,835
7	Tuesday, February 16, 2021	6	-14,427	-18,941	4,514
8	Monday, February 15, 2021	19	-14,240	-18,357	4,117
9	Wednesday, February 17, 2021	18	-14,082	-16,504	2,422
10	Tuesday, February 16, 2021	7	-14,076	-18,962	4,886
<b>2020/21 Winter Average</b>			<b>-4,521</b>	<b>-7,354</b>	<b>2,834</b>



- Between 2/15 and 2/19, exports of 1.6 TWh account for 10% of all winter exports.
- Overall, export patterns were very similar to those observed over the whole winter.

Emergency Procedure	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
100% Spinning Reserve - RTO and/or MAD	5	5	10	3	4	8	2
High System Voltages	7	18	6	0	0	3	0
Minimum Generation Alert	4	13	3	0	1	0	0
Manual Load Dump Warning or Action	1	0	0	0	0	0	0
Cold Weather Alert - Any Region	26	2	2	14	8	1	4
<b>Total</b>	<b>43</b>	<b>38</b>	<b>21</b>	<b>17</b>	<b>13</b>	<b>12</b>	<b>6</b>

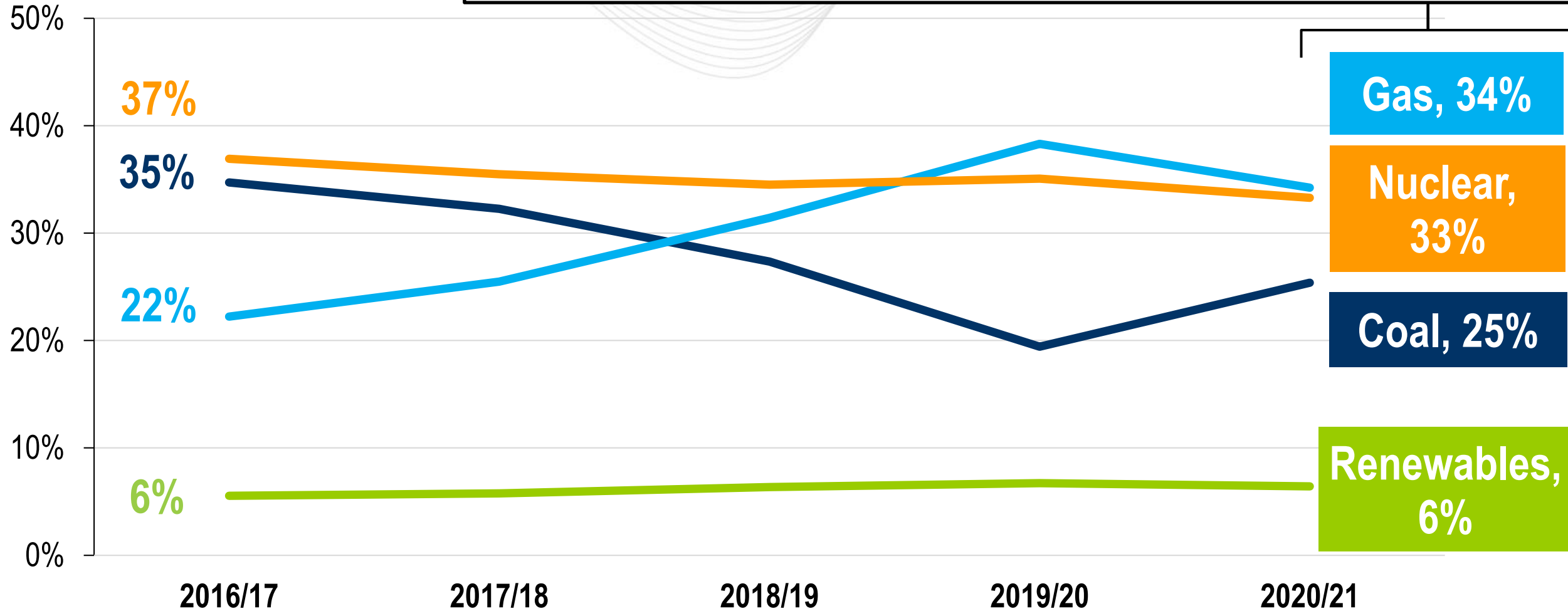
- There were very few Emergency Procedures enacted this winter.
- Aside from high prices for President’s Day weekend gas packages, there were no natural gas pipeline conditions that had significant impacts on Winter operations in the PJM system.

- Interstate pipeline operations were relatively uneventful during this winter period with no major capacity restrictions.
- Underground gas storage was heavily relied upon during February as daily production dropped, particularly in the central U.S.
- Operational Flow Orders have been utilized by many pipelines with greater frequency over the past several winters to manage daily volume imbalances.
- Ratable take requirements (uniform hourly flows) have been enforced with increased authority to manage intraday pressure swings.

- The following slides show the fuel mix of on-line generation for the past five winters for all hours, and for AM/PM peak hours of Feb. 15 – Feb. 19, respectively. Following that is a slide showing average wind and solar performance for all winter hours.
- Throughout December and January, coal's share of the online fuel mix was approximately 23%. High natural gas prices in February likely led to higher coal plant utilization, bringing up the seasonal average to 25%.
- During the week of Feb. 15 – Feb. 19, coal's share of the online fuel mix during daily peak hours was approximately 32%.

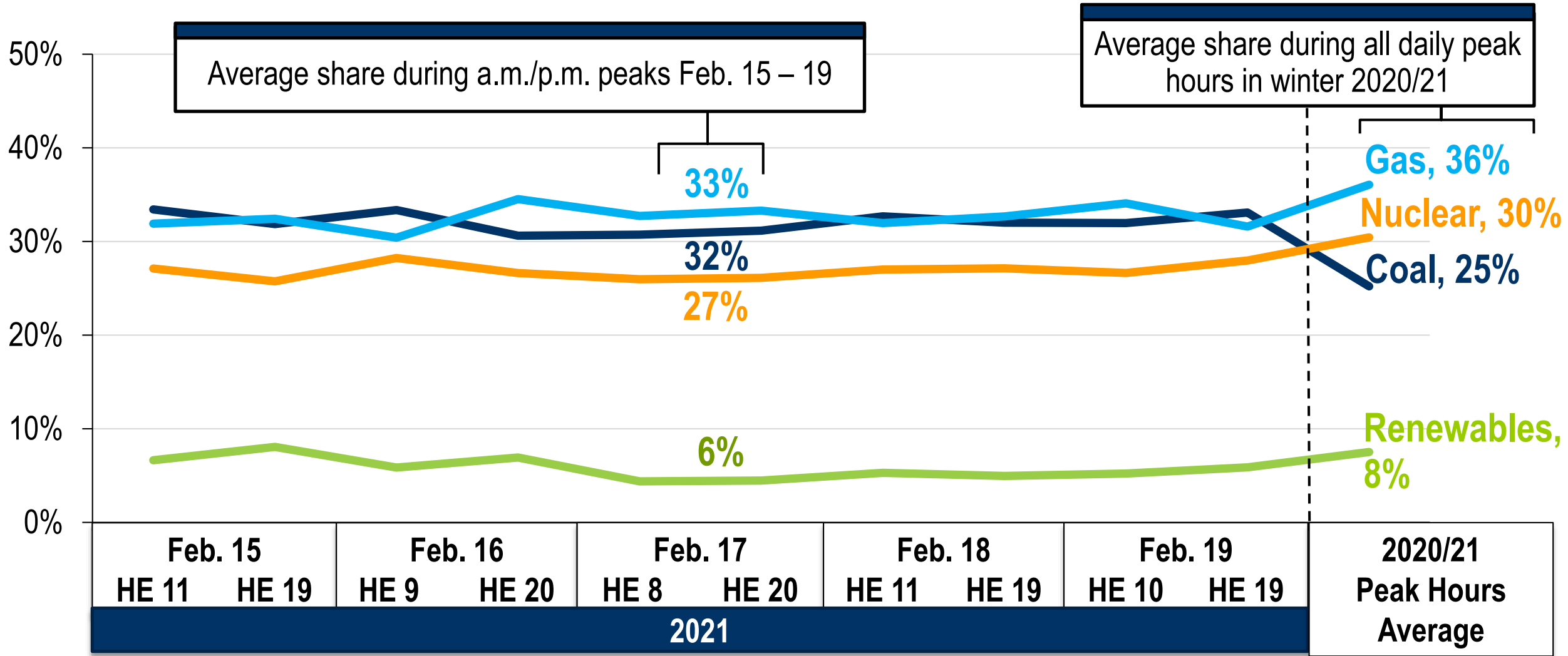
# Historic Online Fuel Mix for All Winter Hours

The historic online fuel mix is nearly identical when looking at just daily peak hours.

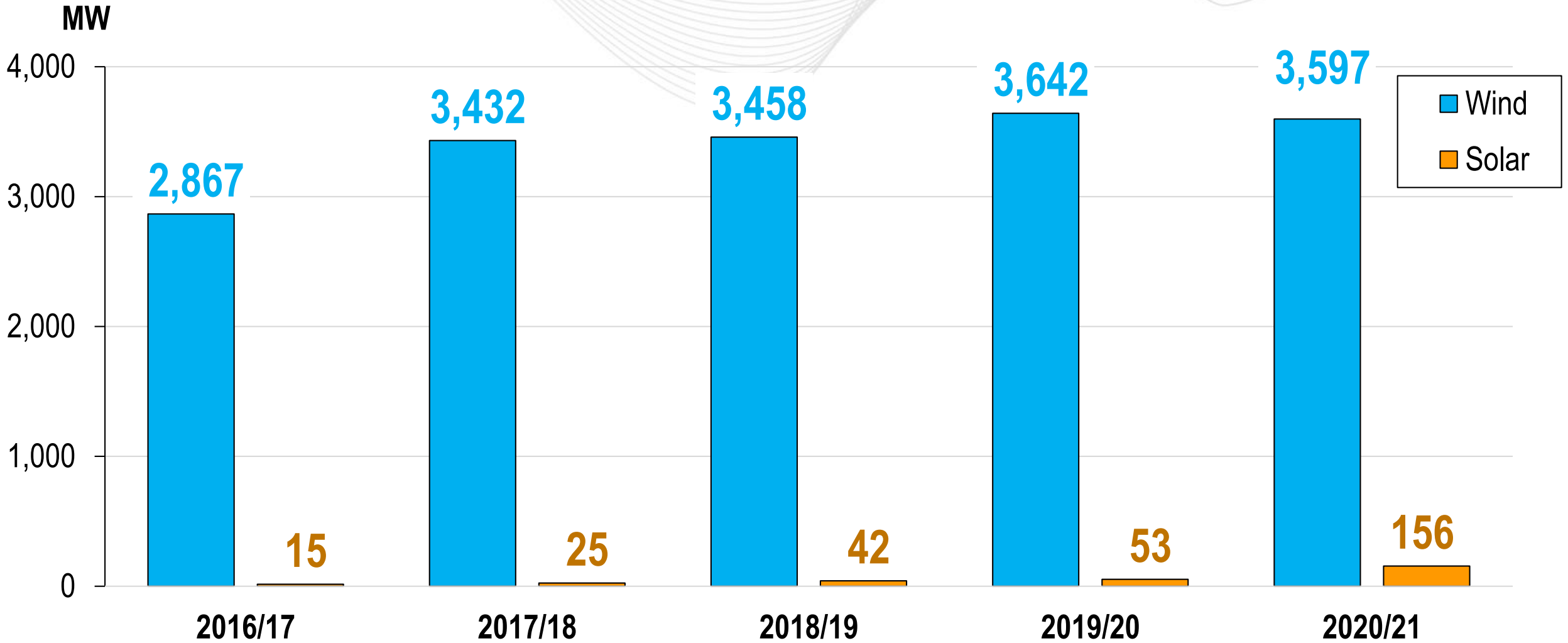




# Online Fuel Mix – AM/PM Peak Hours, Feb. 15 – Feb 19

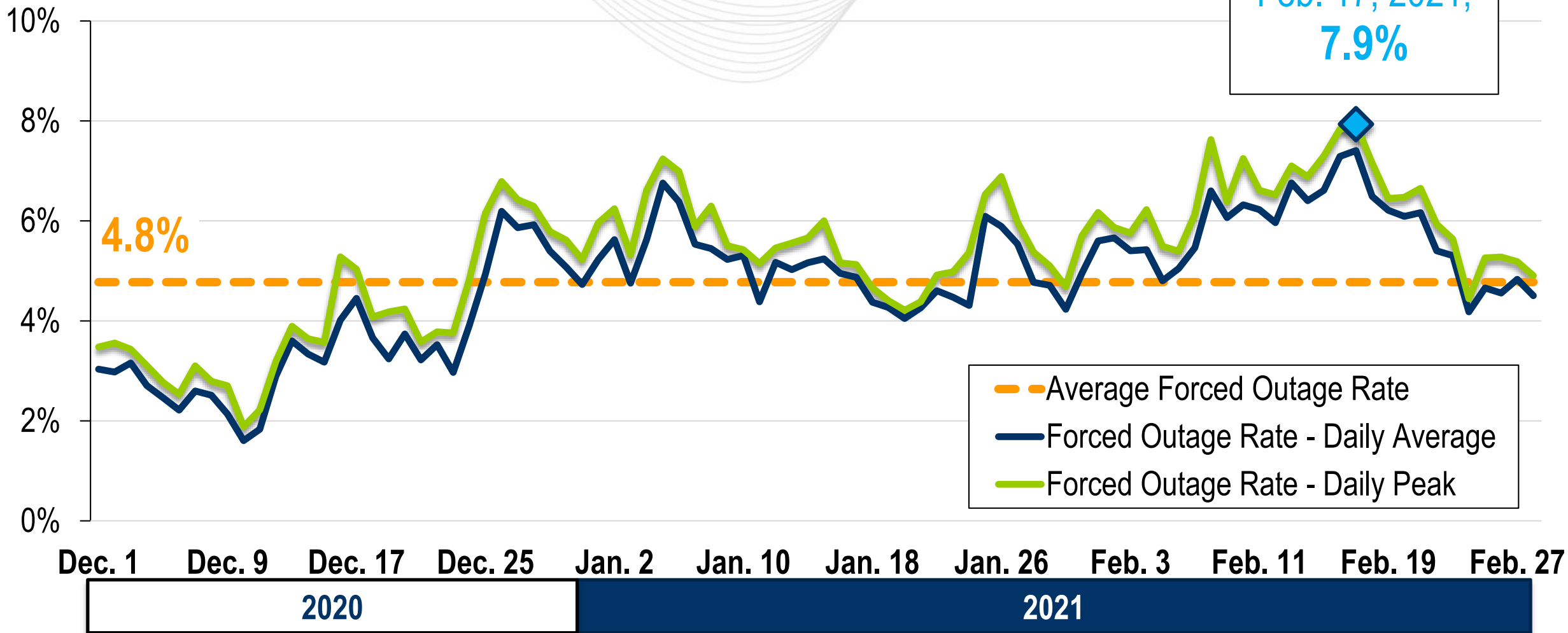


# Renewable Performance for all Winter Hours

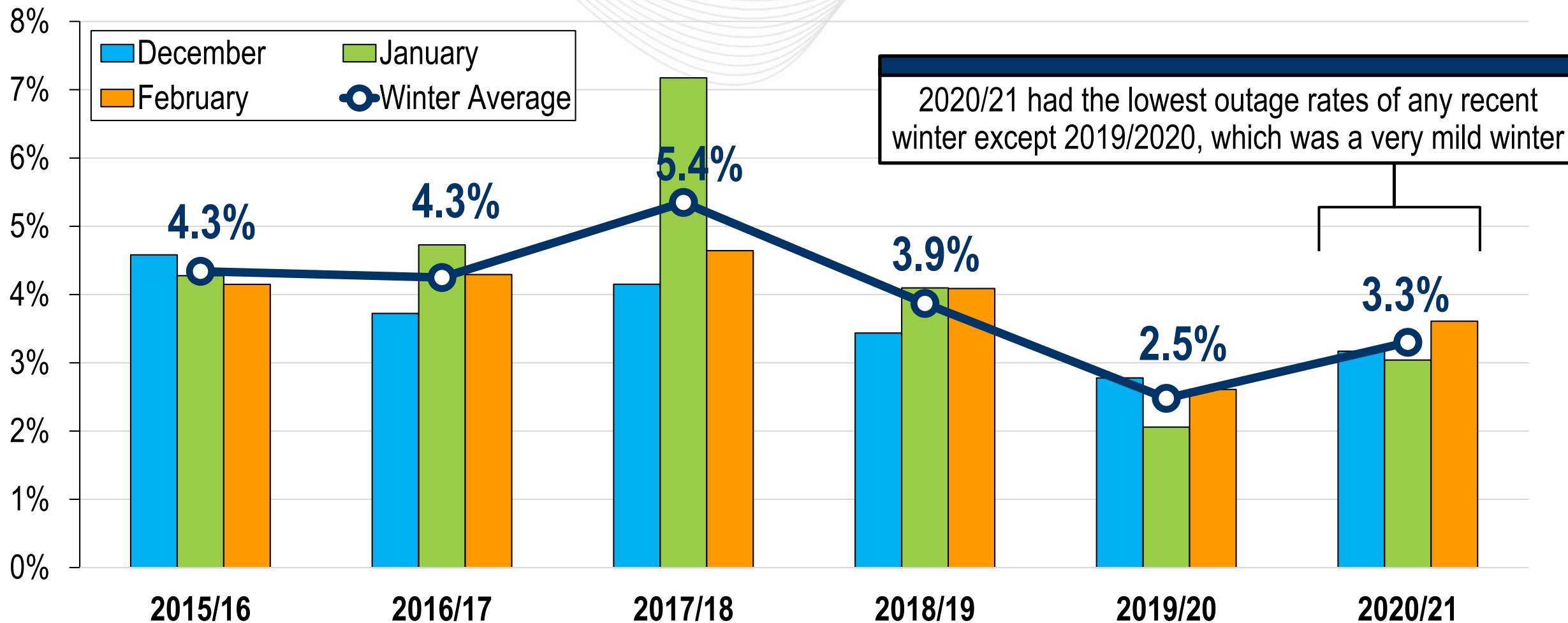


- The following slides show the daily average and daily maximum forced outage rates, as well as the historic average forced outage rates, respectively.
- The daily data is sourced from eDART, however, historical data is from GADS.
- GADS outage rates are lower than any recent winter other than winter of 2019/20.
- GADS outage rates are up slightly from last winter, however, last winter's weather was very mild.

## Forced Outage Rate



## Average Forced Outage Rate



Presenter:  
Rebecca Carroll,  
[Rebecca.Carroll@pjm.com](mailto:Rebecca.Carroll@pjm.com)

**Winter Operations of the PJM Grid:  
December 1, 2020 – February 28, 2021**



**Member Hotline**

(610) 666 – 8980

(866) 400 – 8980

[custsvc@pjm.com](mailto:custsvc@pjm.com)