



# Load Forecast Discussion

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PJM is committed to producing the most accurate load forecast it can, and has already made many enhancements.

2006 - PJM starts producing long-term forecast

2012 – Included additional economic variables

2016 – Introduced end-use variables that capture energy efficiency as well as BtM solar

2020 – Introduced sector models, non-weather sensitive load, and plug-in electric vehicles

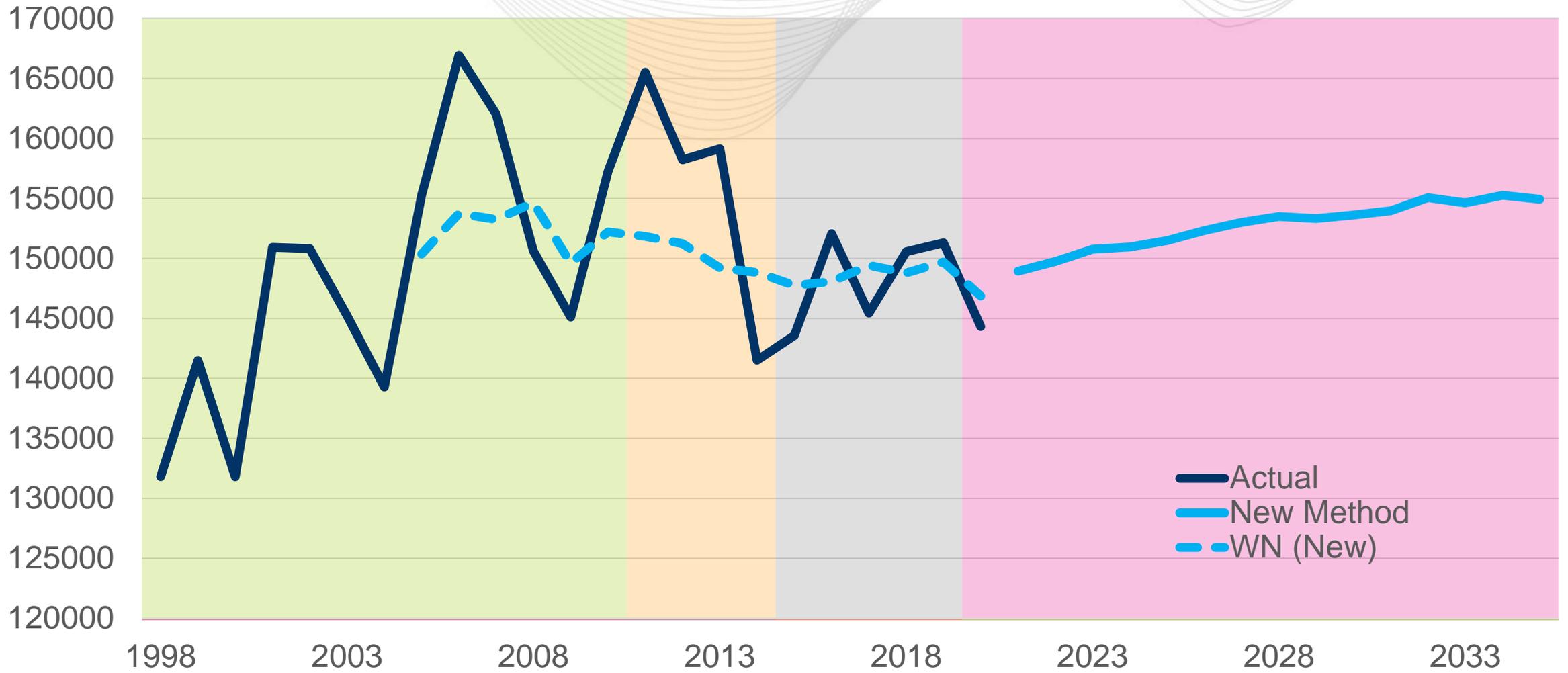
2021 – Refined modeling techniques to better capture sector and non-weather sensitive trends

2022 and beyond - Further refine techniques and forecast granularity. Further consider evolving technologies.



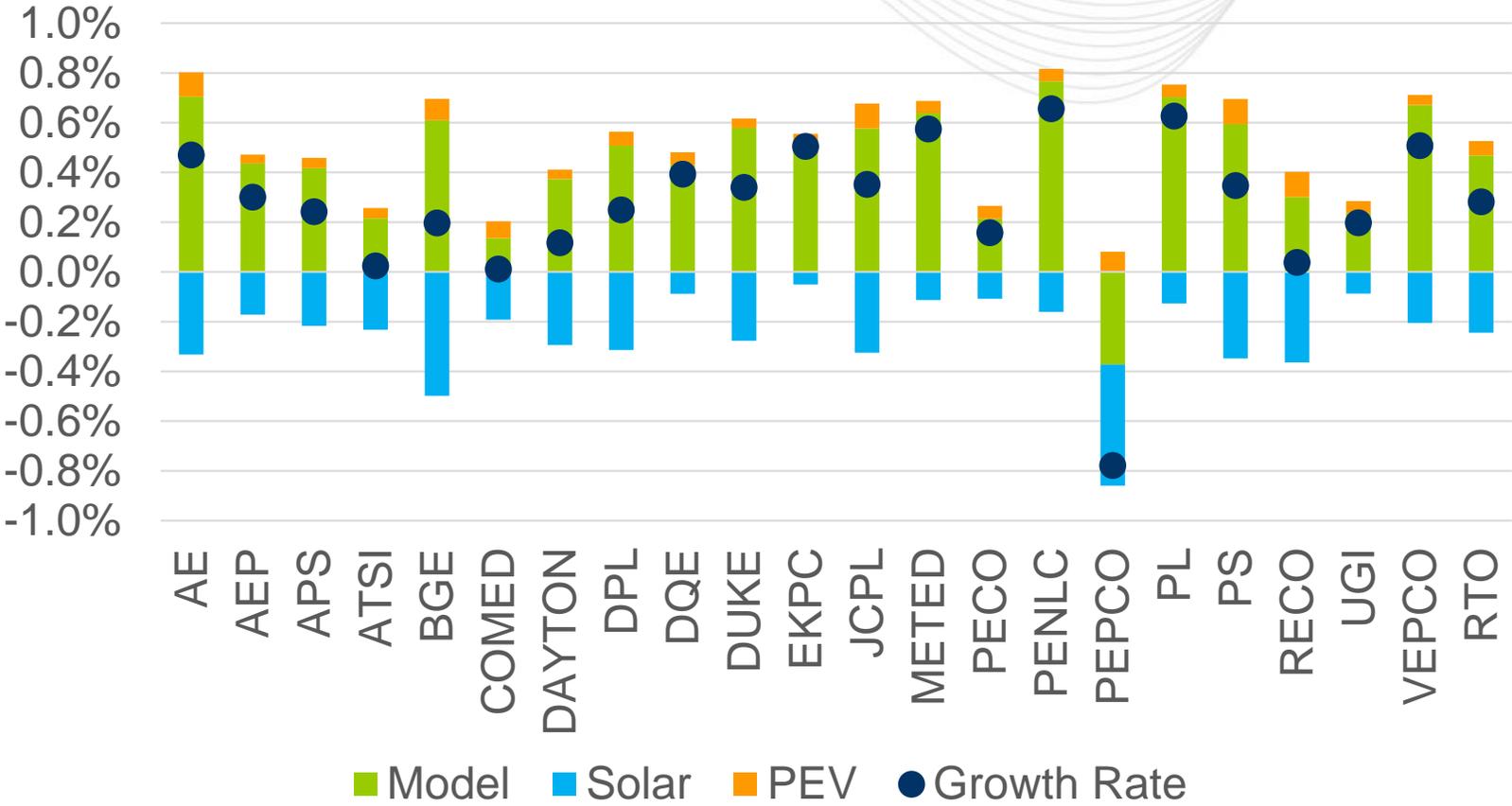
# PJM RTO Summer Peak Forecast Based on New Methodology

*Numbers Subject to Change*



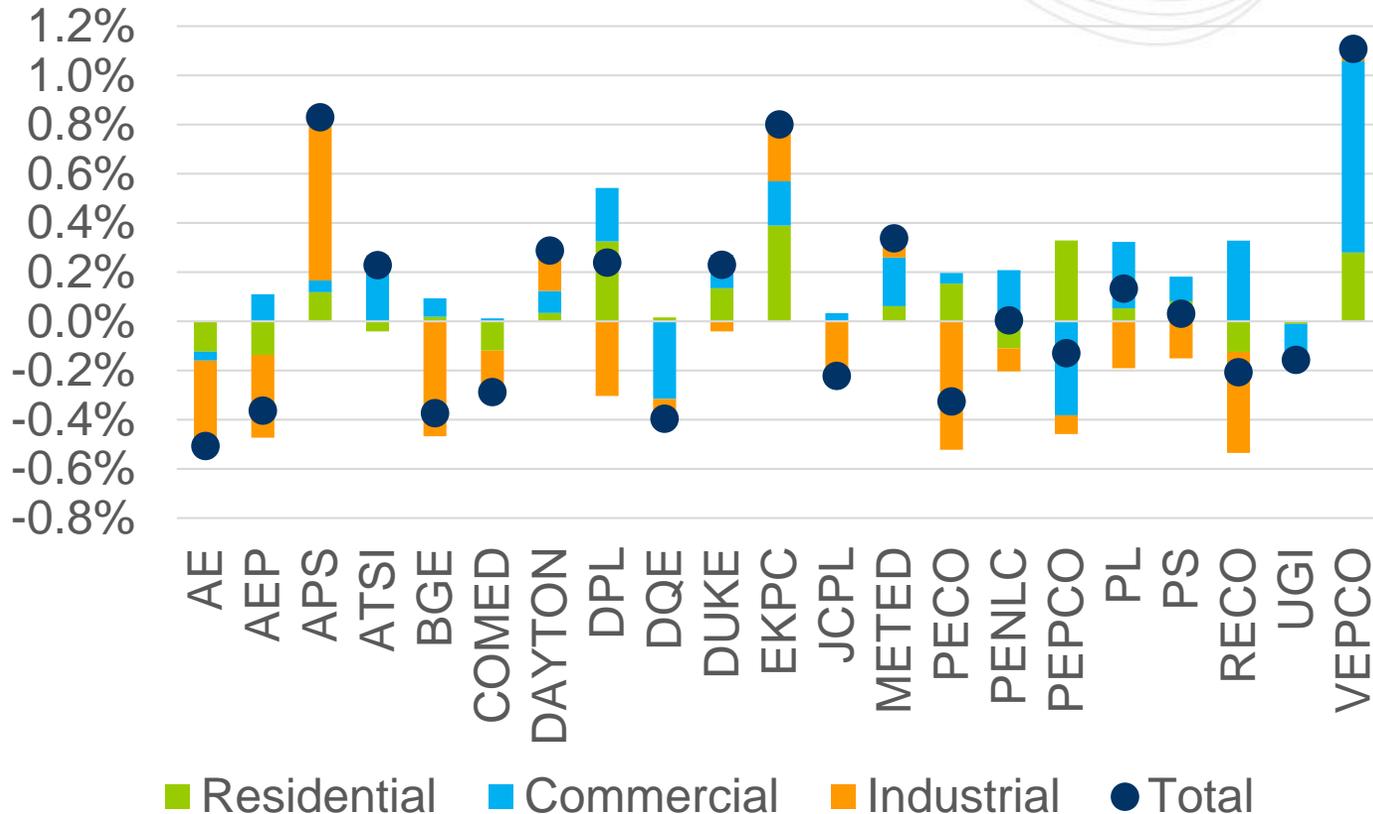
- Period 1
  - Load growth dictated by economics.
- Period 2
  - Load declines due to rise of energy efficiency and behind-the-meter solar offsetting economic gains.
- Period 3
  - Modest gains resume as the balance of economics and efficiency leads to stabilization.
- Period 4
  - Period of economic recovery and long-run growth. Longer-run trends have less drag due to smaller efficiency gains.

## Growth Rates and Contributions (2020-2035)



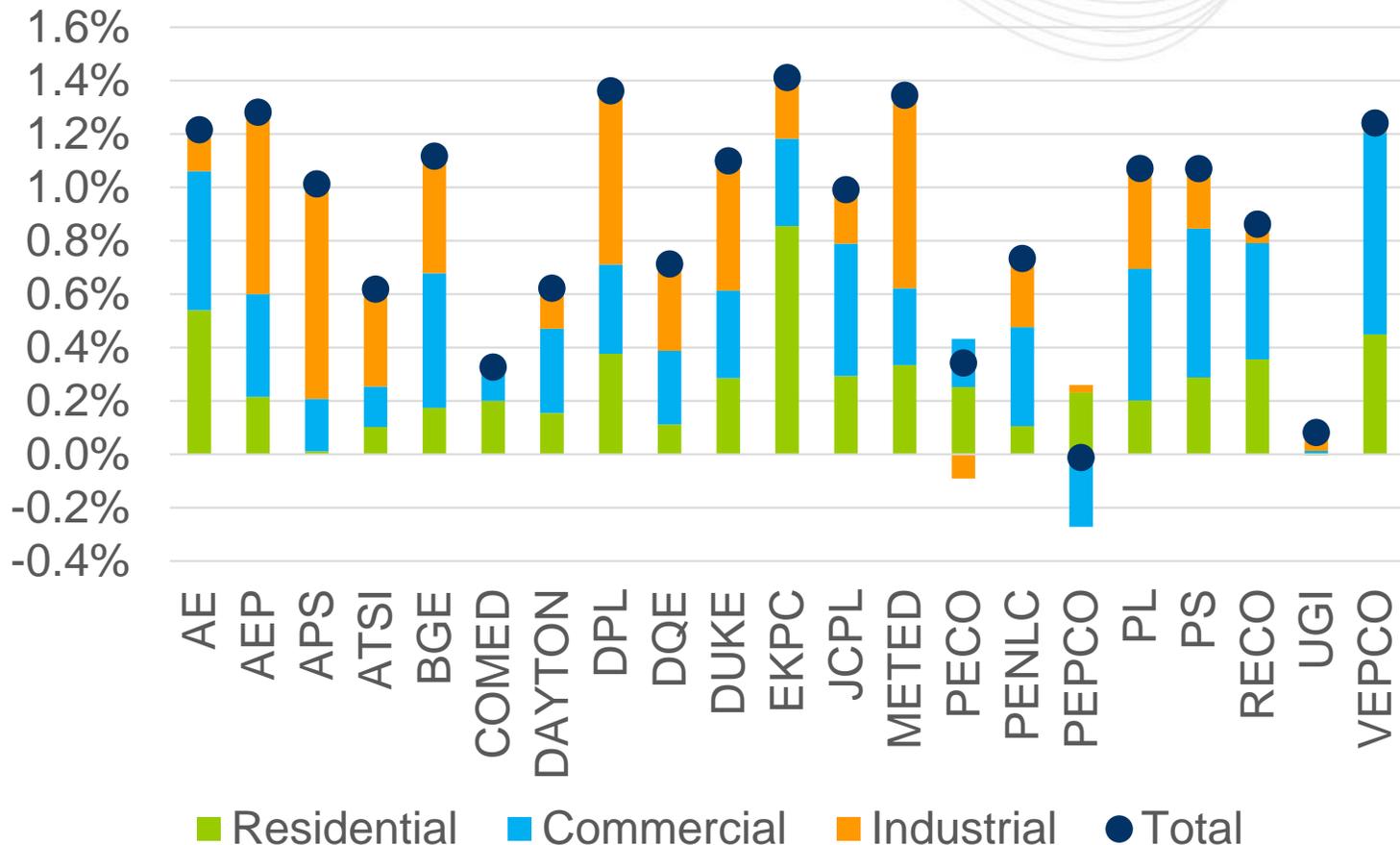
- Separation of expected growth contributions into Model, Solar, and Plug-in Electric Vehicles.
- “Model” is what’s left after accounting for solar and PEV.

## Decomposition of End-Use Growth (2010-2019)



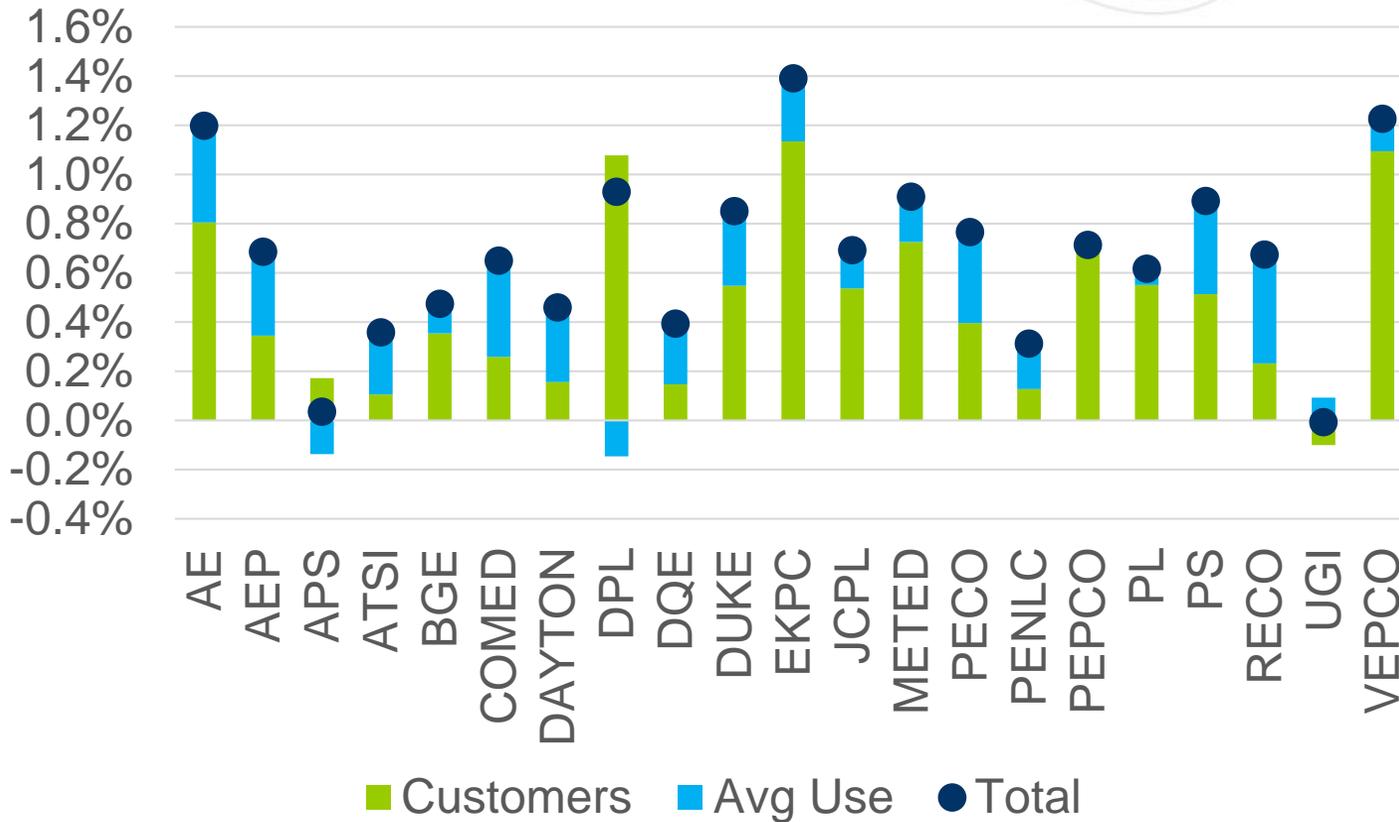
- Residential and Commercial sectors were relatively stable.
- Industrial was noticeably more volatile. Some zones had rather large drags despite relatively small industrial concentrations (e.g. AE and BGE).

## Decomposition of End-Use Growth (2020-2035)



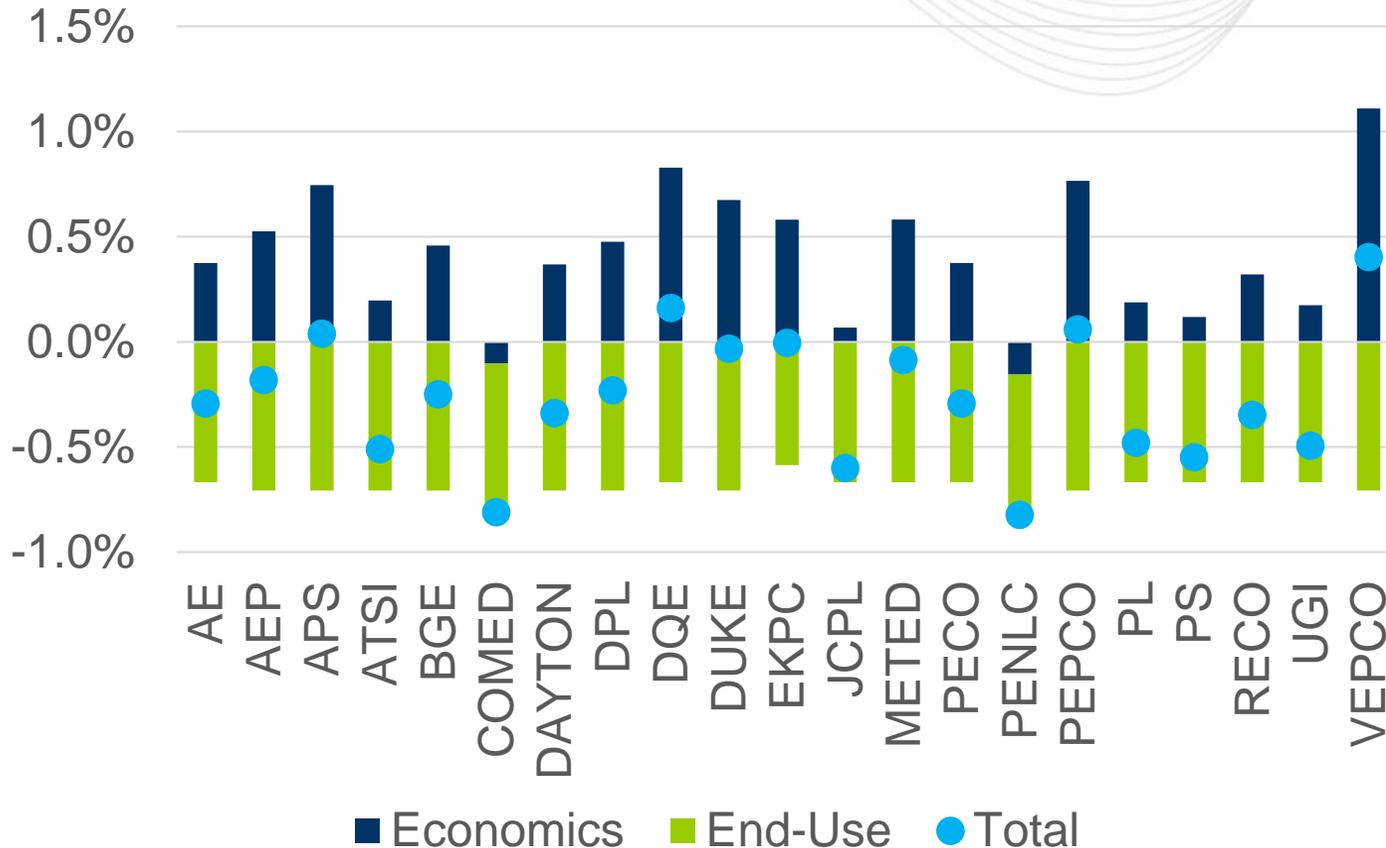
- Residential and Commercial generally add to growth, through a combination of expected economic conditions as well as smaller efficiency gains in the forecast.
- Industrial tends to add to growth, driven primarily by forecasted economic growth.

## Decomposition of Residential Growth (2020-2035)



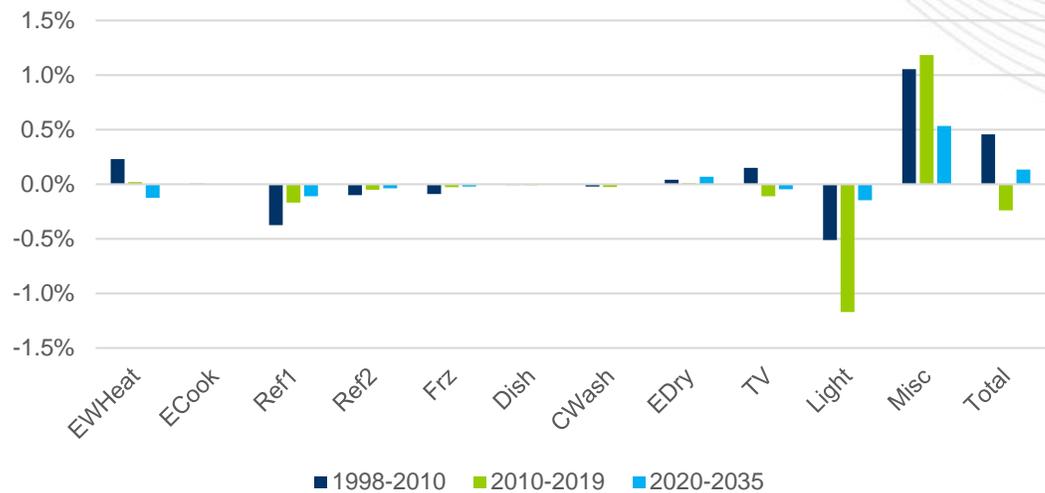
- Zones continue to show growth in customers, due to growth in households, some faster than what was seen in recent history.
- Average use is a function of ongoing penetration of electric uses outpacing the concurrent gains in efficiency.

Commercial Drivers (2020-2035)



- Commercial model develops a relationship between electric demand and drivers (economics and end-use). Electric demand growth has historically out-paced driver growth; this is captured in the model.
- Forecast reflects similar economic growth to recent history and continued efficiency gains (though at a slower pace).

Mid-Atlantic Residential Other End-Use Growth Contributions

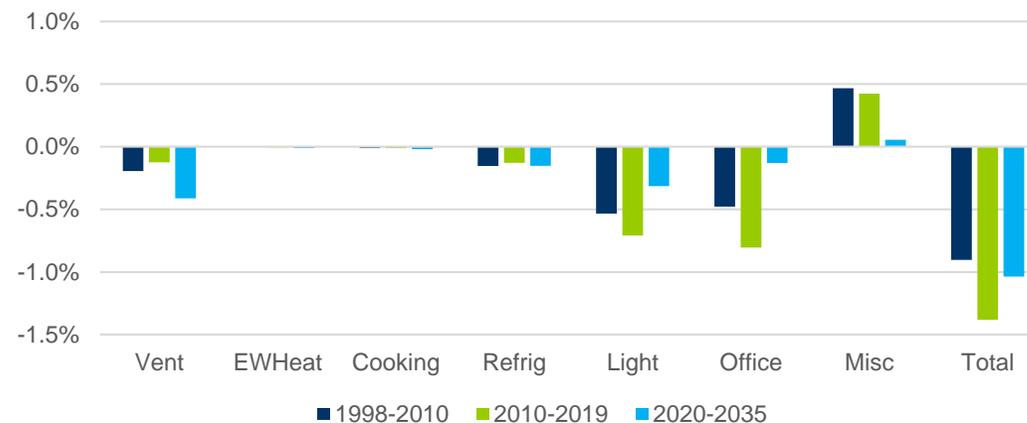


Intensity is a measure of saturation of various end-uses adjusted for their relative efficiency over time.

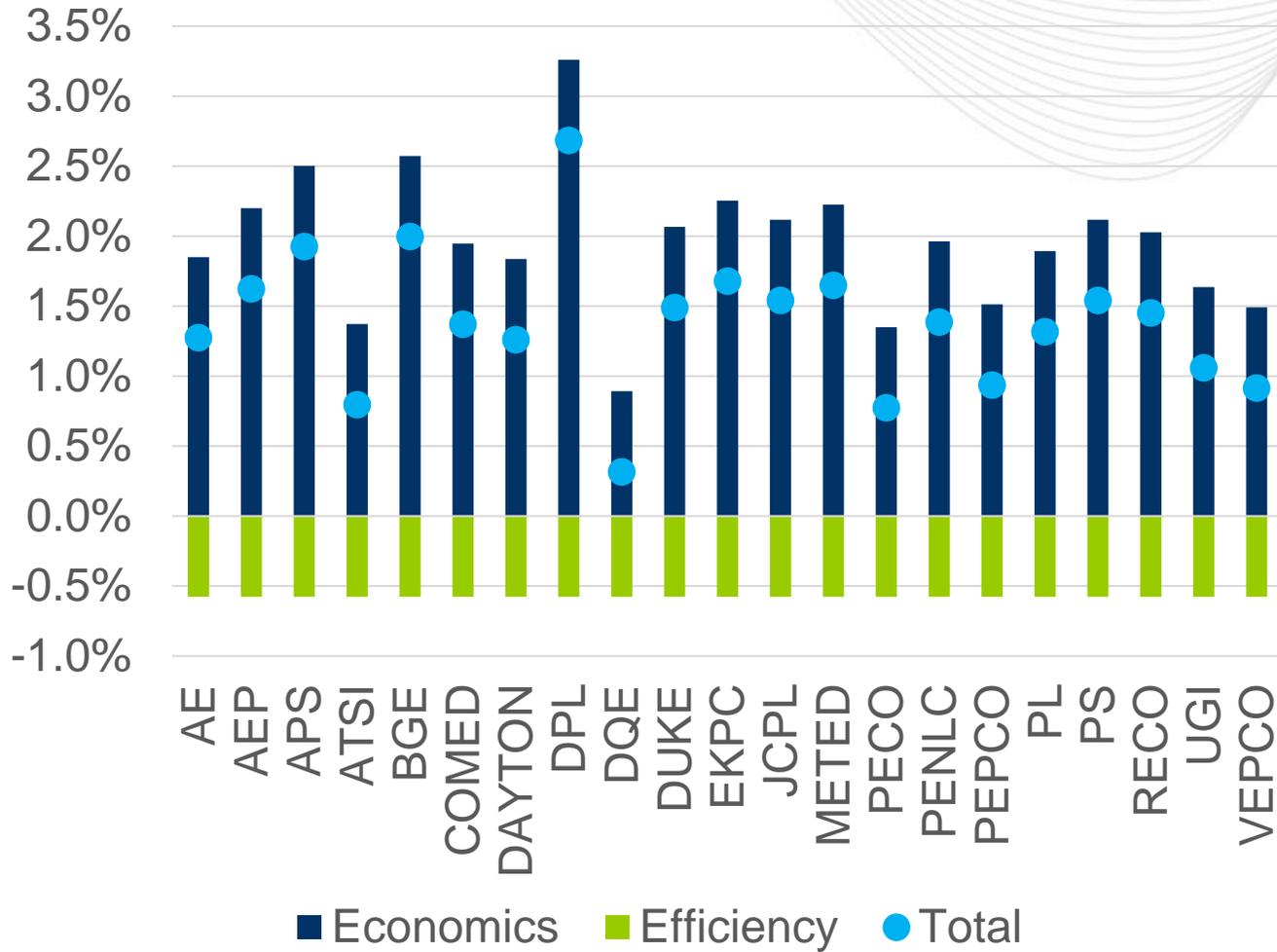
Forecast time period is impacted by these intensity trends.

- Residential – Slight drag to slight positive
- Commercial – Smaller drag

Mid-Atlantic Commercial Other End-Use Growth Contributions



# Drivers of Gross Demand by Sector - Industrial



- Driver variable is a product of economics and efficiency term. Efficiency term is a national metric.
- Economics vary across footprint and are the primary driver of industrial growth.



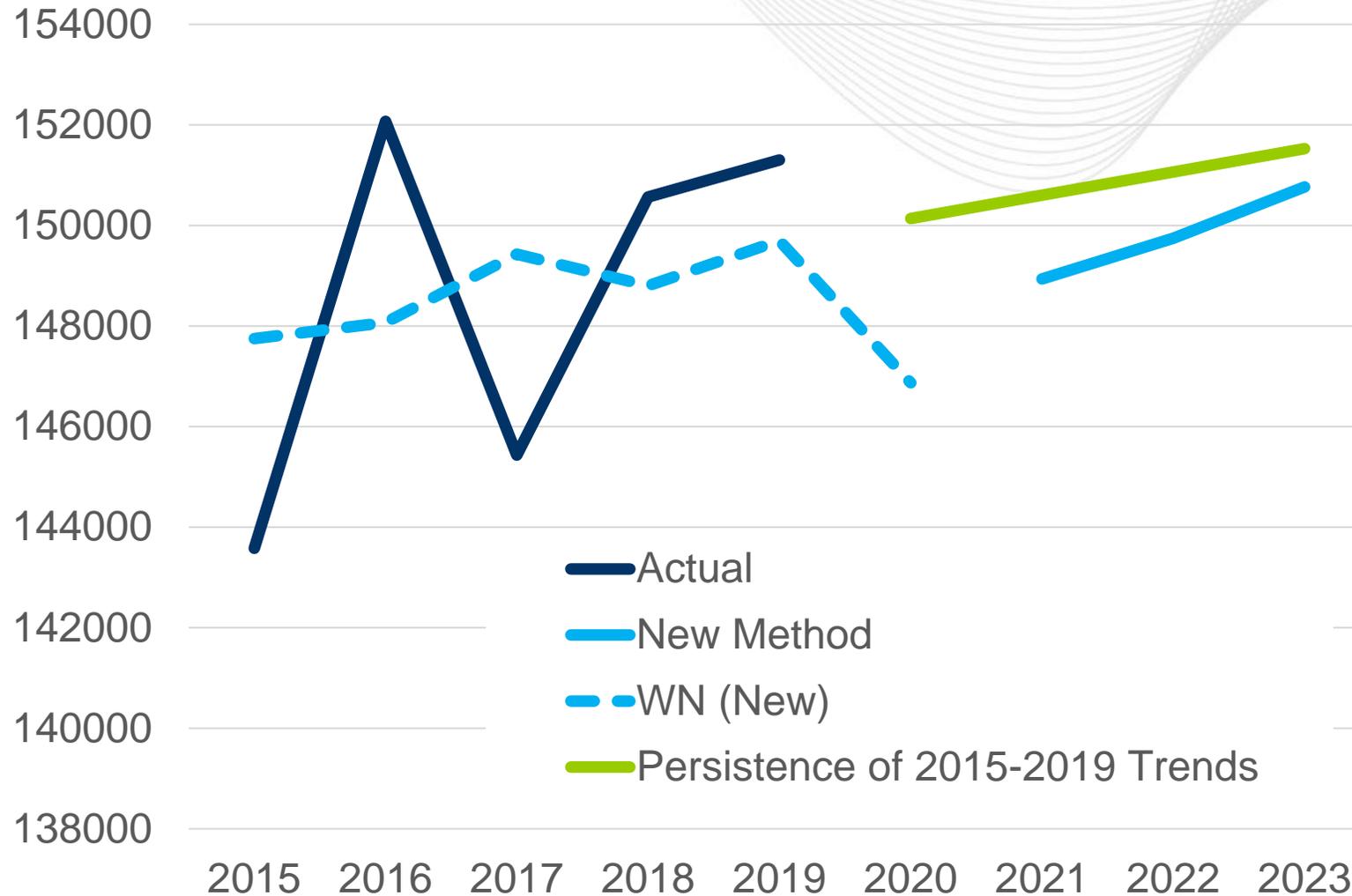
# Reasonableness of Forecast: Historical Exceedance of Forecast Peaks

**Number of Historical Daily Peaks That Exceed Forecasted Peaks**

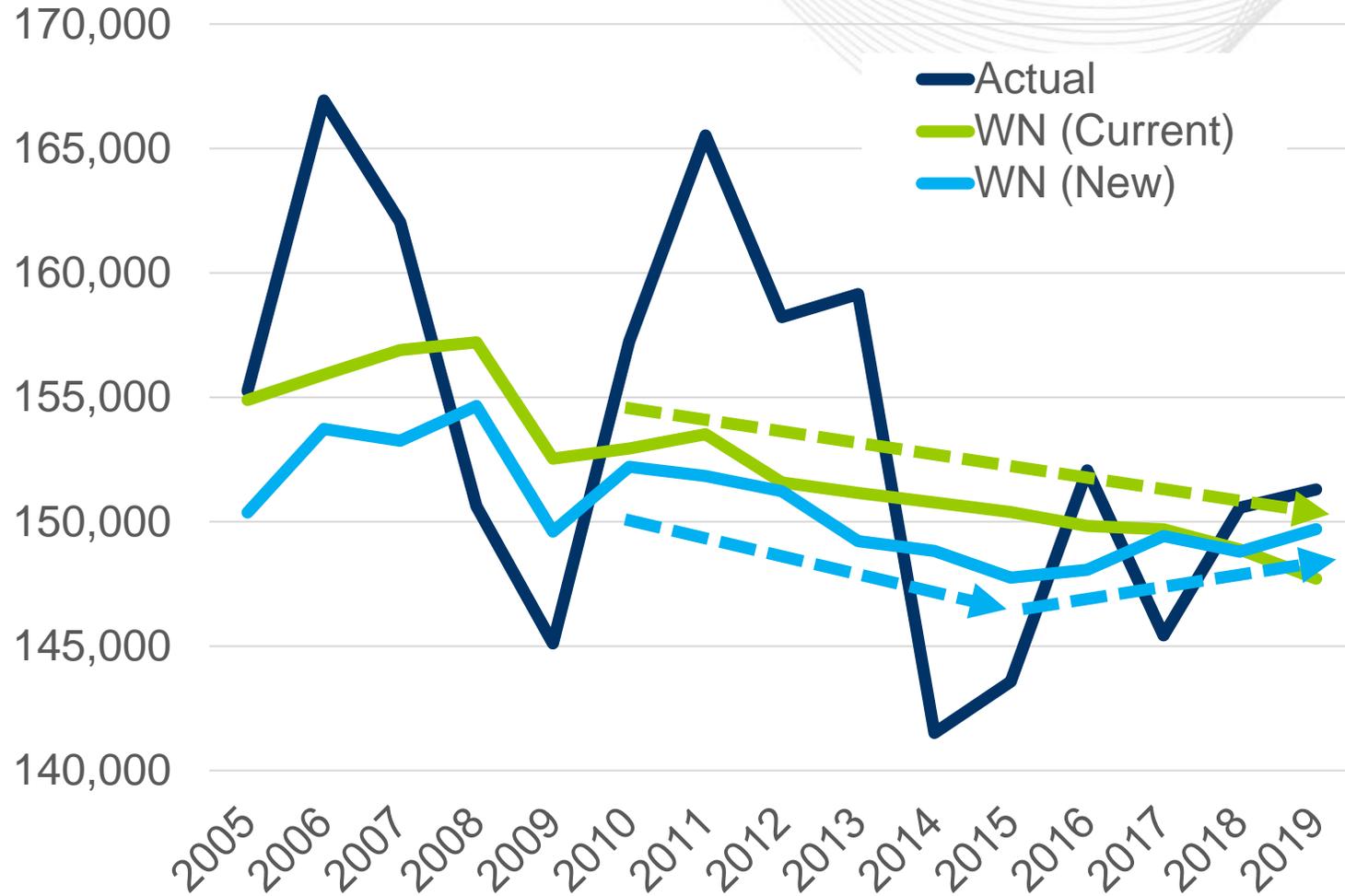
Forecast Year	Peak Forecast	# of Historical Days Which Exceeded Forecast (2016-2020)	Weather Percentile of Lowest Load Which Exceeds Peak Forecast (2016-2020)	Lowest Load Which Exceeds Peak Forecast (2016-2020)	Highest Load Which Exceeds Peak Forecast (2016-2020)
2021	148,936	5	48%	149,412	152,069
2022	149,745	4	50%	150,573	152,069
2023	150,767	3	56%	151,073	152,069
2024	150,959	3	56%	151,073	152,069
2025	151,484	1	59%	152,069	152,069

In recent years, we have had actual peak load values that have exceeded our forecast for the next five years and these peaks were not on days on which weather conditions were extreme.

# Reasonableness of Forecast: Comparing Forecast to Trend

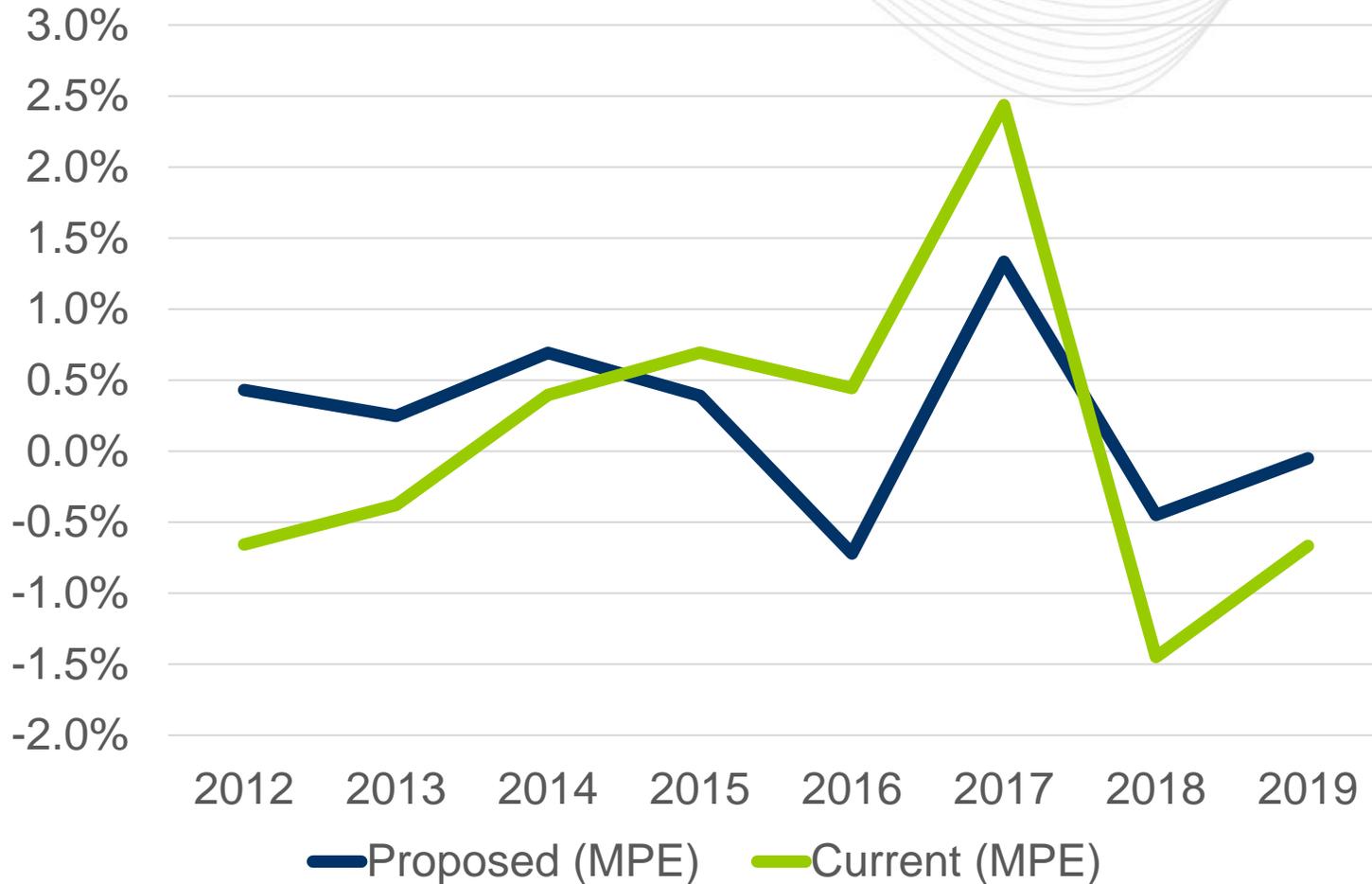


- Compare forecast to naïve forecast that load continues on its 2015 to 2019 path.
- Though the new forecast closes the gap due to expected economic recovery, new forecast does not reach this trend.
- Forecast does not seem unreasonably high relative to what has been seen in recent history.



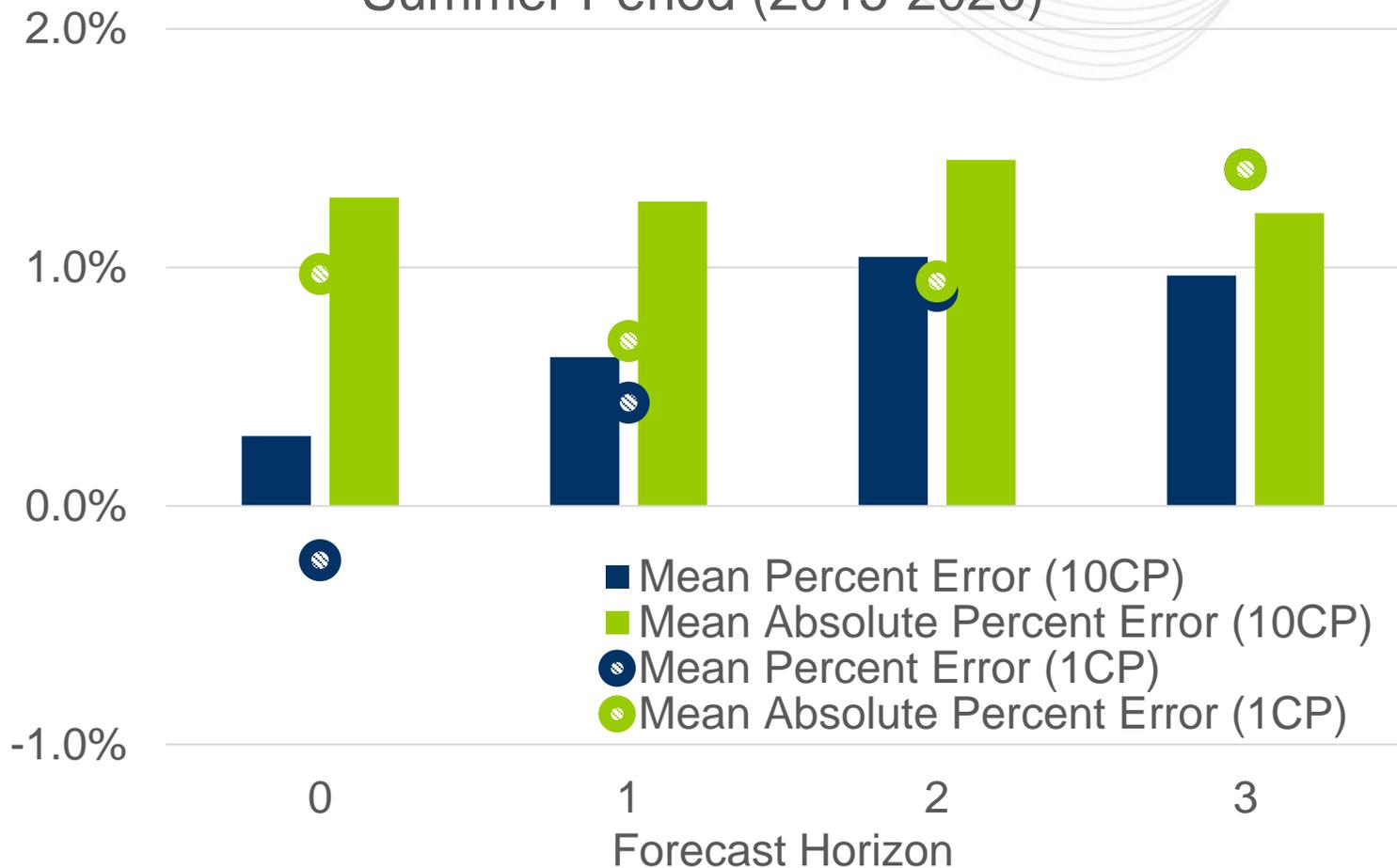
- Old weather normal trend showed declines from 2010 to 2019.
- New weather normal trend shows declines from 2011 to 2015 followed by mild growth from 2015 to 2019.

## Summer Zero Year Forecast Error



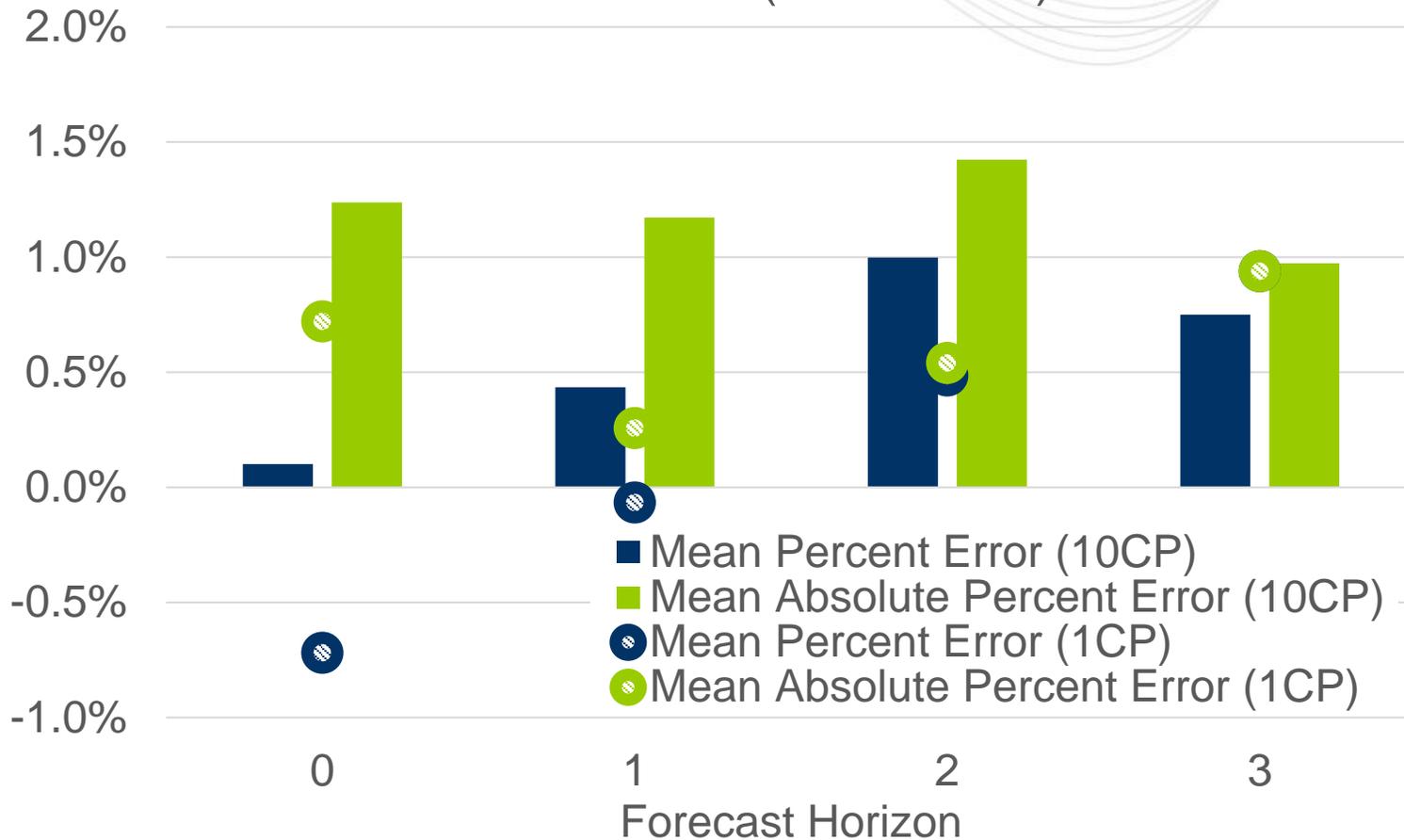
- Current trend creates the illusion of declines in the 2015-2019 time period, by over-forecasting in 2016 and 2017 and subsequently under-forecasting in 2018 and 2019.
- New error trend is more centered on zero. It is a more accurate model for indicating trends in weather normalized load.

Forecast Model Accuracy  
Summer Period (2015-2020)



- Forecast model that we are implementing with 2021 Load Forecast has been accurate with perhaps some small positive error (not an abundance of data).
- Our goal is to always improve upon accuracy through stakeholder engagement and methodology improvements.
- 2020 increased positive error at all forecast horizons due to the Pandemic.

Forecast Model Accuracy  
Summer Period (2015-2019)



- PJM considers 2020 to be an anomaly.
- Forecast model that PJM is implementing with 2021 Load Forecast has been accurate with perhaps some small positive error (not an abundance of data).
- Our goal is to always improve upon accuracy through stakeholder engagement and methodology improvements.

## Use 10 Year Estimation Period for Sector Models

- Residential, Commercial, and Industrial sector models are based on annual data. Because of data limitations, we use data back to 1998. The 2021 Forecast will have data from 1998-2019 or 22 observations.
  - There is no rule on minimum number of observations.
  - Some say we should target at least 10 observations per explanatory variable (sector models have 1-3 variables), thus ideally we would have a minimum of 10-30 observations.
  - Stakeholder has expressed an interest in sector models only being run on the most recent 10 year period.
  - PJM has concerns that this would add instability in model fit.

- Commercial model results indicate that reducing the estimation period to 10 years is not stable nor desirable.
  - Model attributes a negative coefficient to the driver variable (economics + end-use) for 8 zones. This is akin to saying that energy efficiency increases load.
  - Model has worse fit than using entire time period. A comparison of R-squared shows an average of 0.9 with full estimation period versus 0.7 with shortened estimation period.
- Non-weather sensitive results are inconsistent with underlying drivers.
  - Negligible recovery from recession and acceleration in declines
    - Realistic in the context of more modest efficiency gains?

- Suggestion has been made to use 15 years rather than 10 years.
  - Examination of Commercial model using 15 year estimation period indicates that concerns of stability and fit are not resolved.
    - 5 zones have negative coefficients on driver variable.
    - Fit is worse (average R-sq of 0.6 vs 0.9 with entire estimation period)
  - What is the issue that is trying to be solved?
    - PJM views the new model forecast results to be consistent with the independent variables of economics, end-use efficiency, solar, and PEVs.

- Model estimation period for the 2021 Load Forecast will extend through August 31, 2020. Two potential paths:
  - Status Quo: Do nothing additional
    - The forecast impacts of the pandemic would still be captured via the economic forecast.
  - Control: Limit or eliminate the impact of current situation on the assumption of future trends.
    - Option A: Don't include the load data post March 1, 2020 in the model.
    - Option B: Add variables to the model that mitigate the impact.
    - Note: The forecast impacts of the pandemic would still be captured via the economic forecast.

We continue to seek stakeholder feedback on our assumptions, methodologies, and results to help produce the most accurate forecast possible.

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## Load Forecast



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