2021 Preliminary PJM Load Forecast

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Resource Adequacy Planning

Load Analysis Subcommittee
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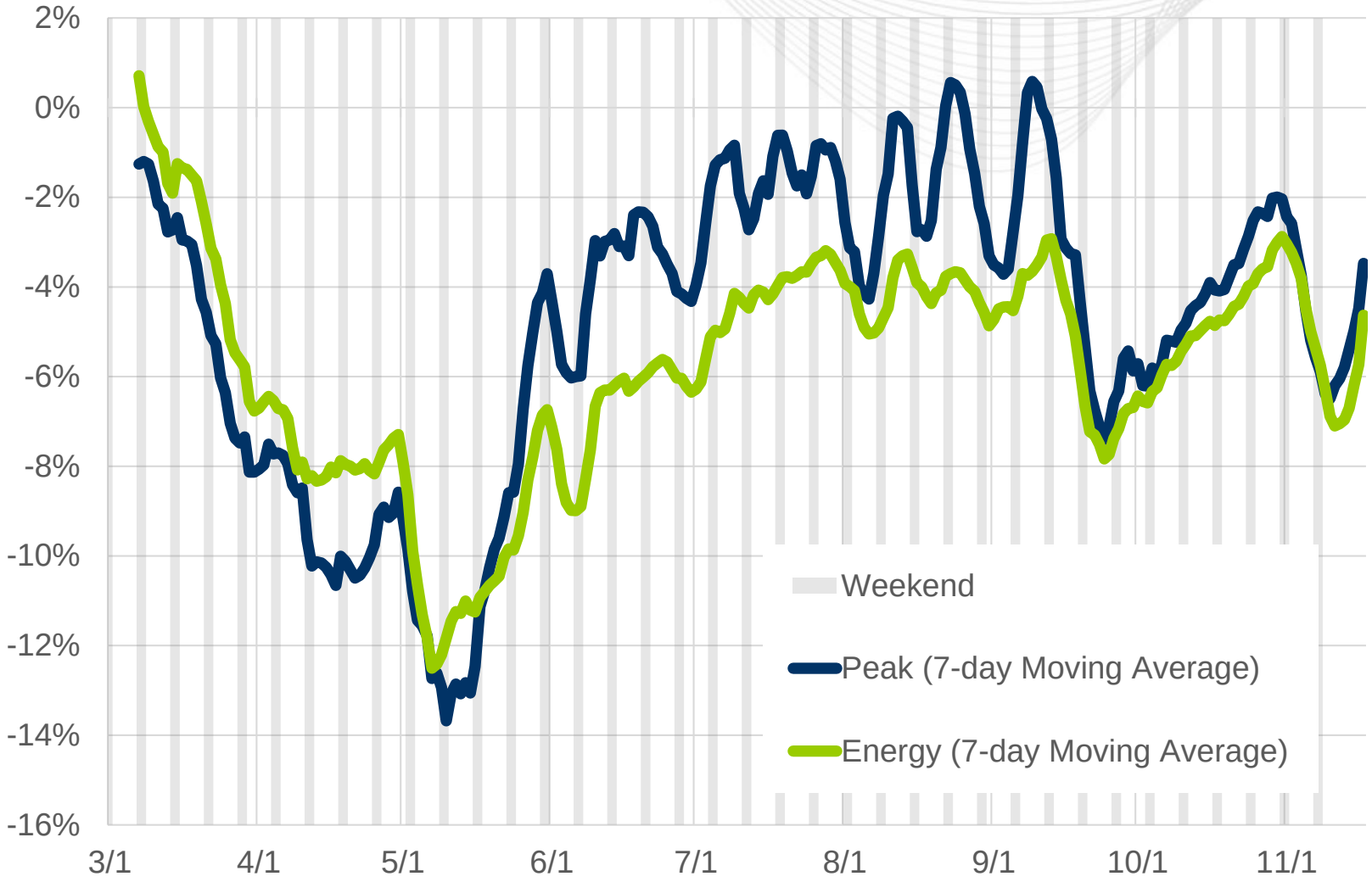
COVID-19

Estimated Impact of COVID-19

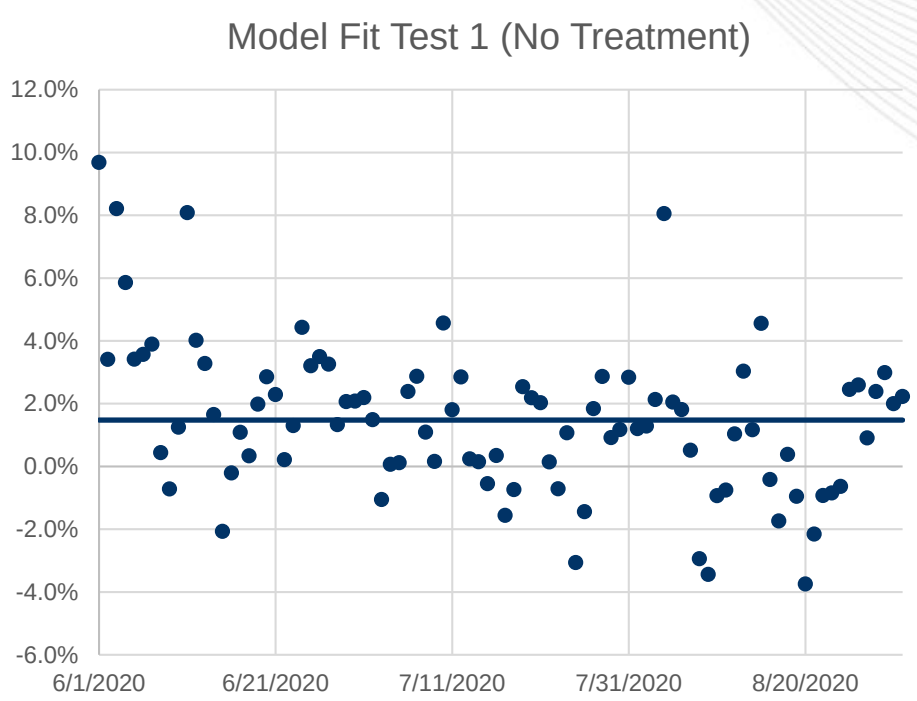


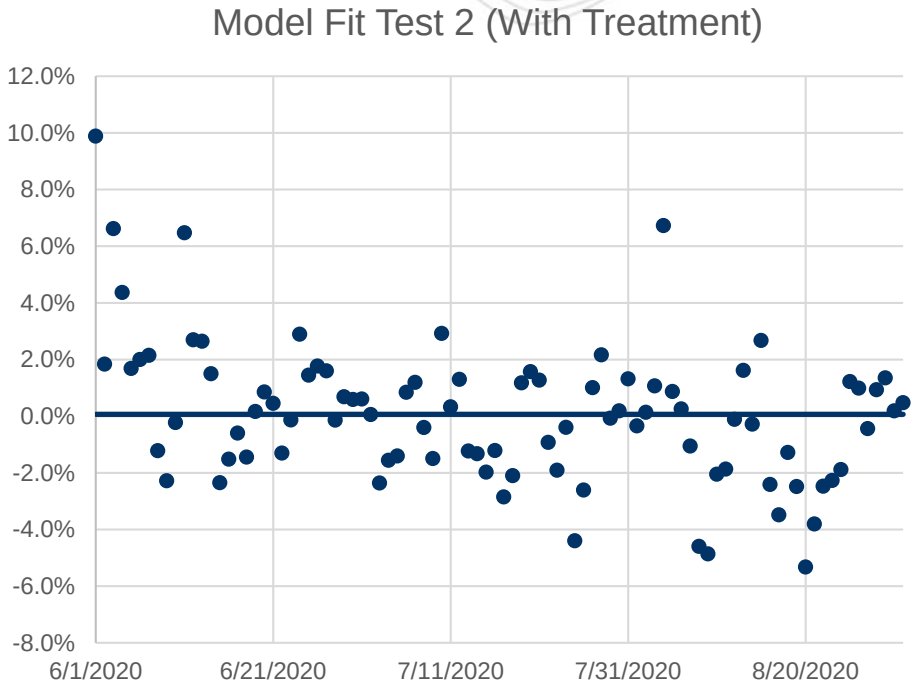
- Two types of impacts
  - Weakened economy depressed load
  - Behavior patterns contributed to increased weather sensitivity and thus load during cooling and heating periods

Forecast tests

- Economic impacts of COVID-19 reflected in economic variables.
  - Test 1: No change to model structure
  - Test 2: Add binary variables that interact with heating and cooling variables. Take value of 1 during March to August 2020 and 0 otherwise.

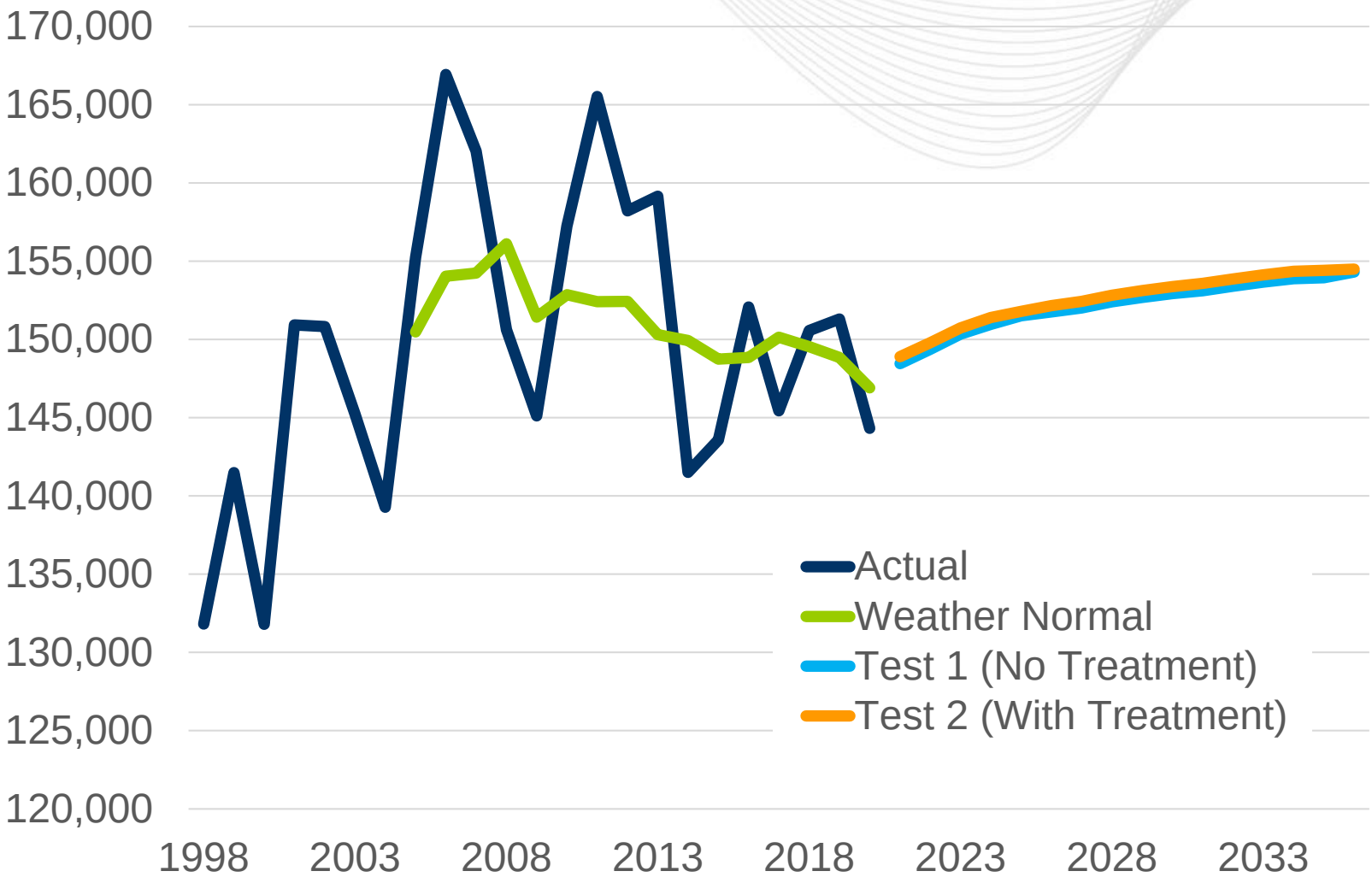
Model Fit Across 2020 Summer Days





- Behavior is different in 2020
  - On average the model with no treatment over-fits, implying that the behavior change is sufficient enough that it is impacting parameter estimates.
  - Model with treatment has a better fit, mitigates impact on parameter estimates.

Treatment Effect



- Treatment does not have a large impact on the forecast.
- Will use treatment in model.

Discussion of Risks on Input Assumptions

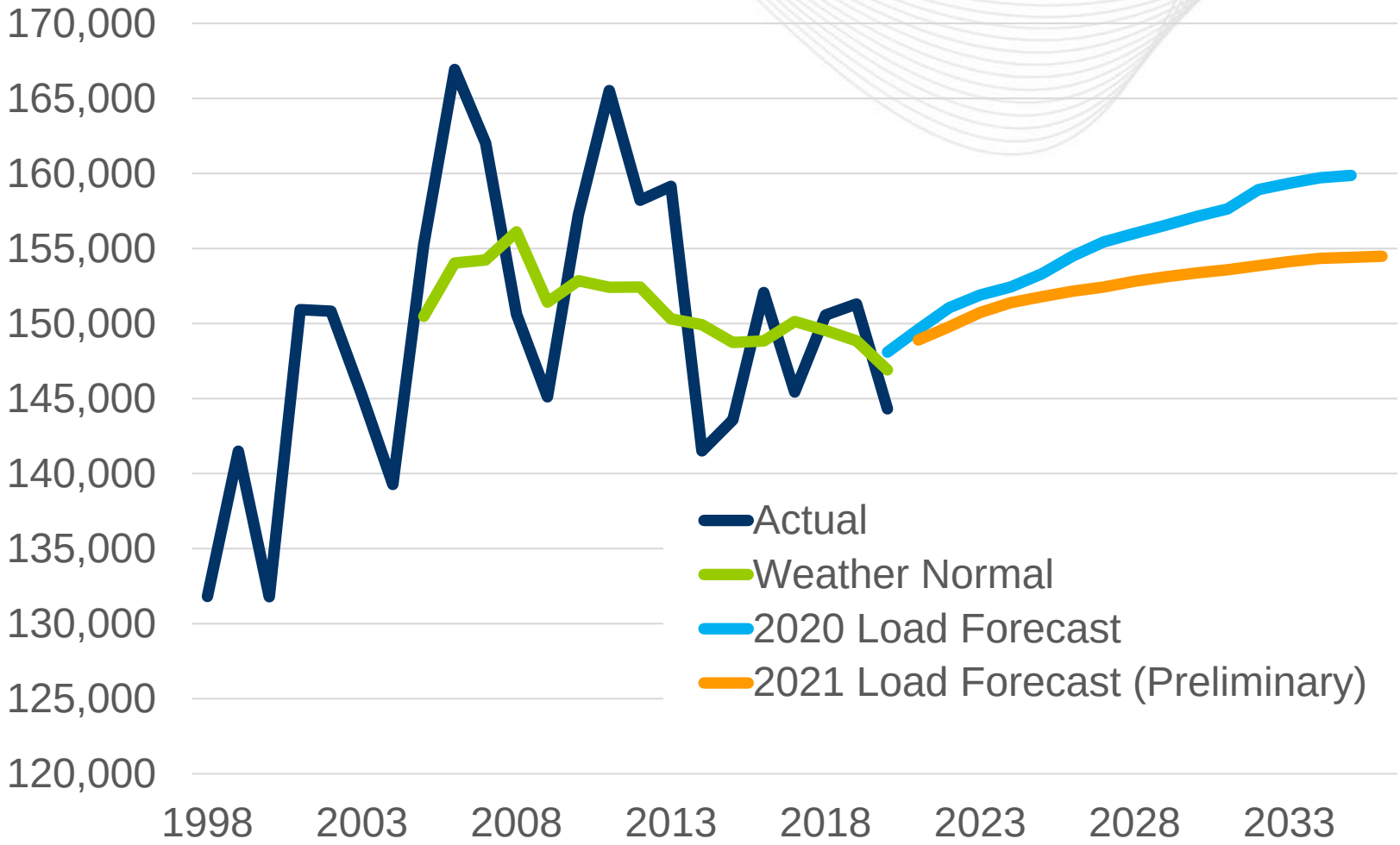
- Economics
  - Risk of economic forecast being too high?
    - Forecasts were generally too high coming out of last recession. This would contribute to over-forecasting of load.
- Efficiency and Distributed Solar
  - Recession impacts may cause households and businesses to delay efficiency upgrades and solar purchases.
    - This would contribute to under-forecasting of load.
- Long-term
  - Permanent behavioral changes of increased WFH would likely increase load. How much would that be offset by reduced Commercial load?

Forecast

Model Parameters

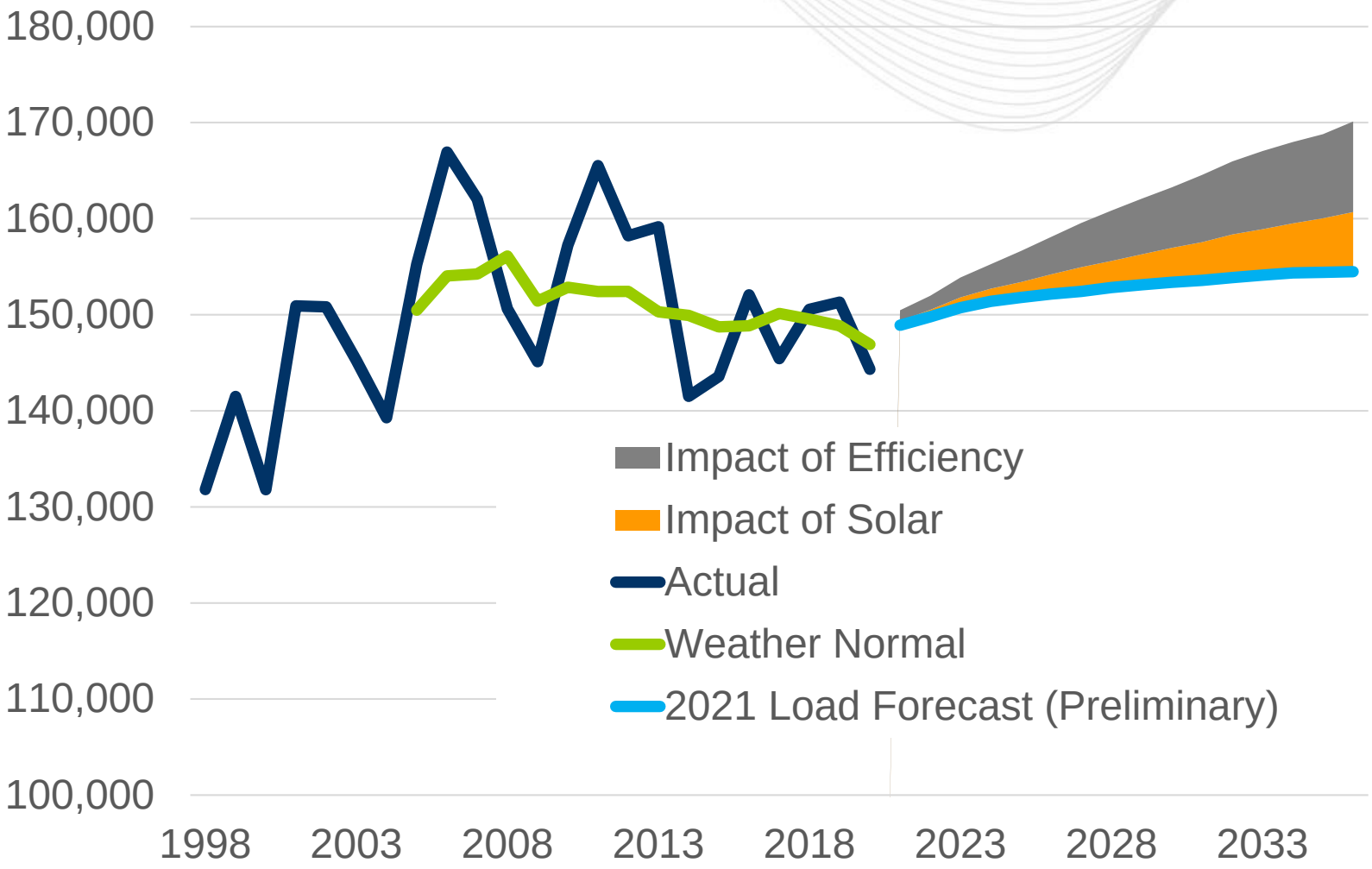
- Estimation Period: January 2011 through August 2020
- Weather Simulation: 1993 to 2019 (351 Scenarios)
- End Use Data: Based on Itron's 2020 release
  - Calibration 1998-2019 using EIA 861 data
- Economics: September 2020 vintage from Moody's Analytics
- AWS Solar Addbacks & IHS Solar Forecast (zonal & peak allocation by PJM)
- Forecast Adjustments – APS, BGE, COMED and Dominion

2021 PJM RTO Preliminary Summer Peak Forecast



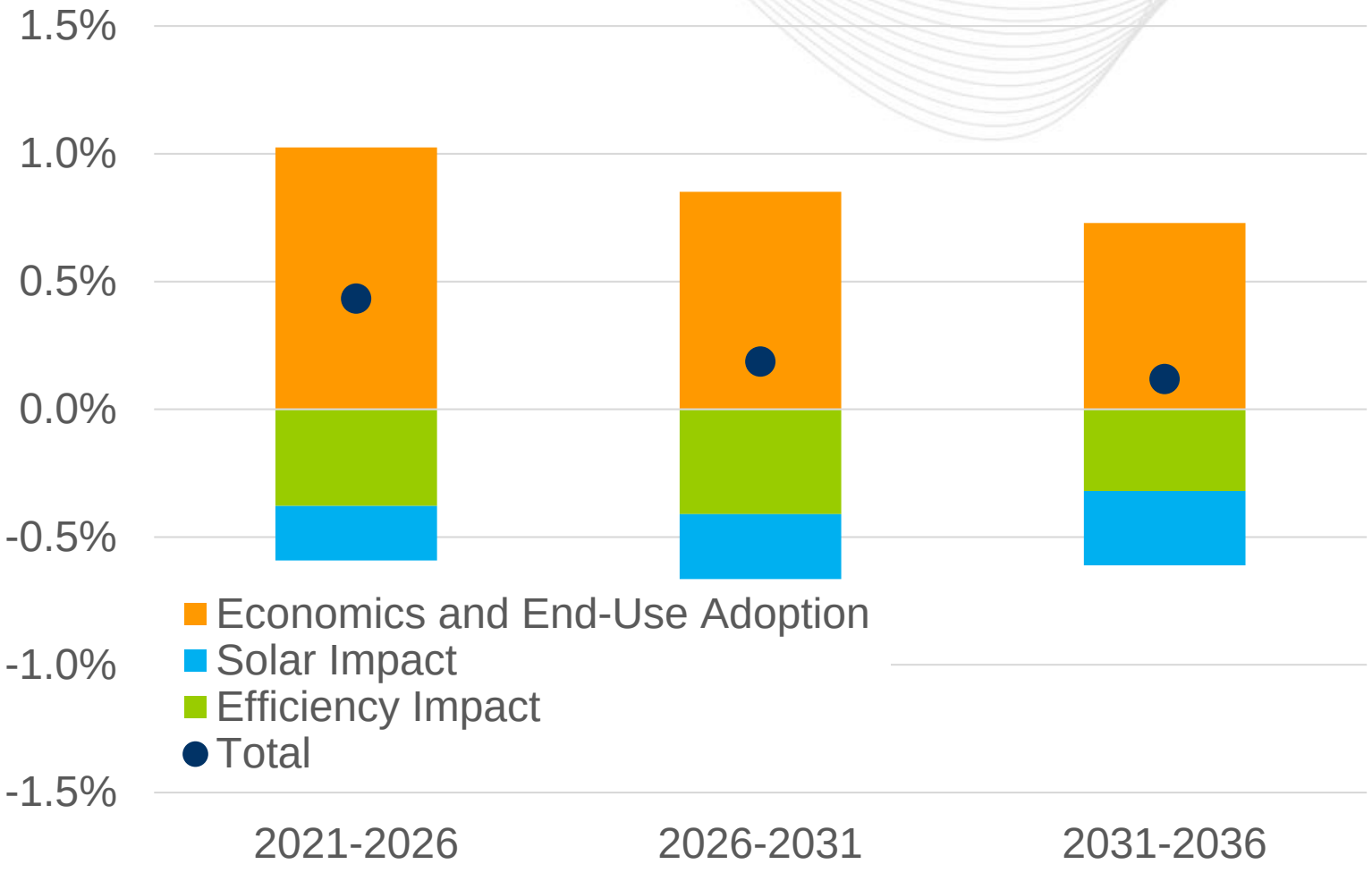
- 15-year Annualized Growth Rate
  - 2020 LF: 0.5%
  - 2021 LF: 0.2%
- Select year comparisons (2021 LF vs 2020LF)
  - 2023: Down 0.8%
  - 2025: Down 1.0%
  - 2035: Down 3.4%

Impact to Summer Forecast from Distributed Solar and Energy Efficiency



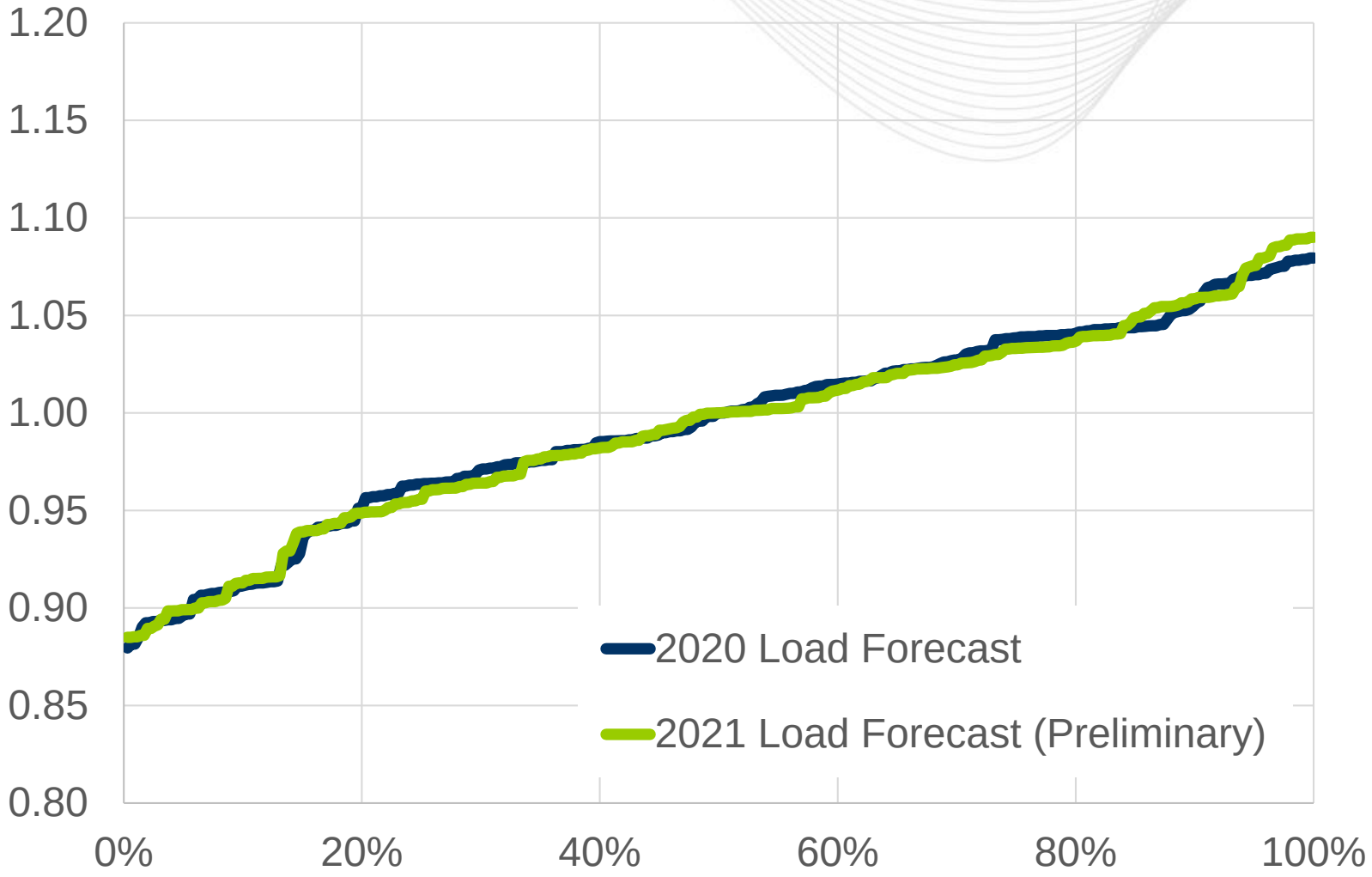
- Efficiency and Behind-the-Meter Solar offset load growth from economic and end-use adoption.
- Without these trends 15-year average load growth would be 0.6 percentage points faster (0.8% vs 0.2%). The savings are split roughly 60/40 between efficiency and solar, respectively.

Summer Forecast Annualized Growth Contributions



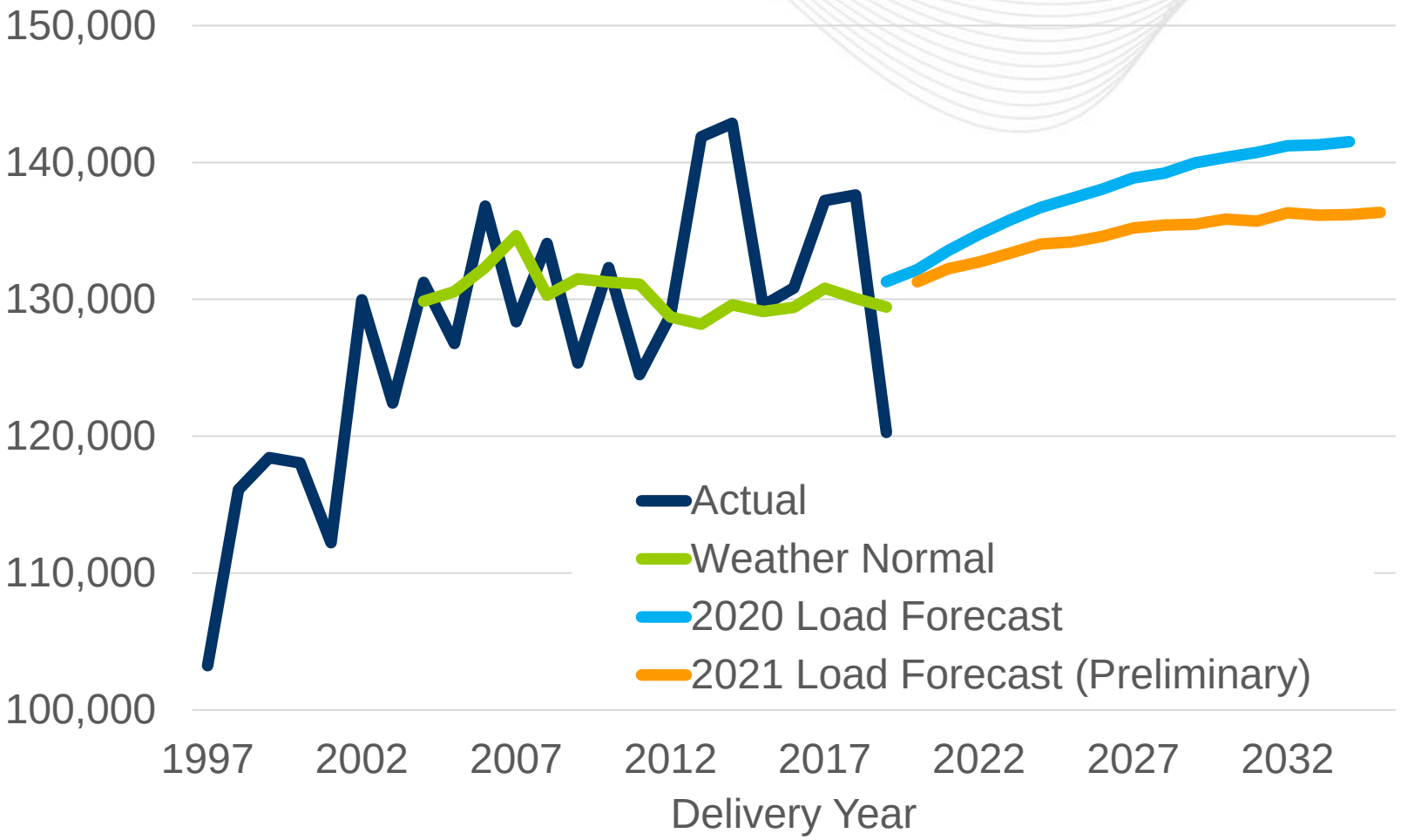
- Early part of forecast horizon influenced by economic recovery.
  - Relatively large economic contributions
  - Temporarily reduced solar
- Long run more modest economic and end-use adoption offset by solar and efficiency gains.

2023 Summer Peak Distribution
50/50 equals 1.0



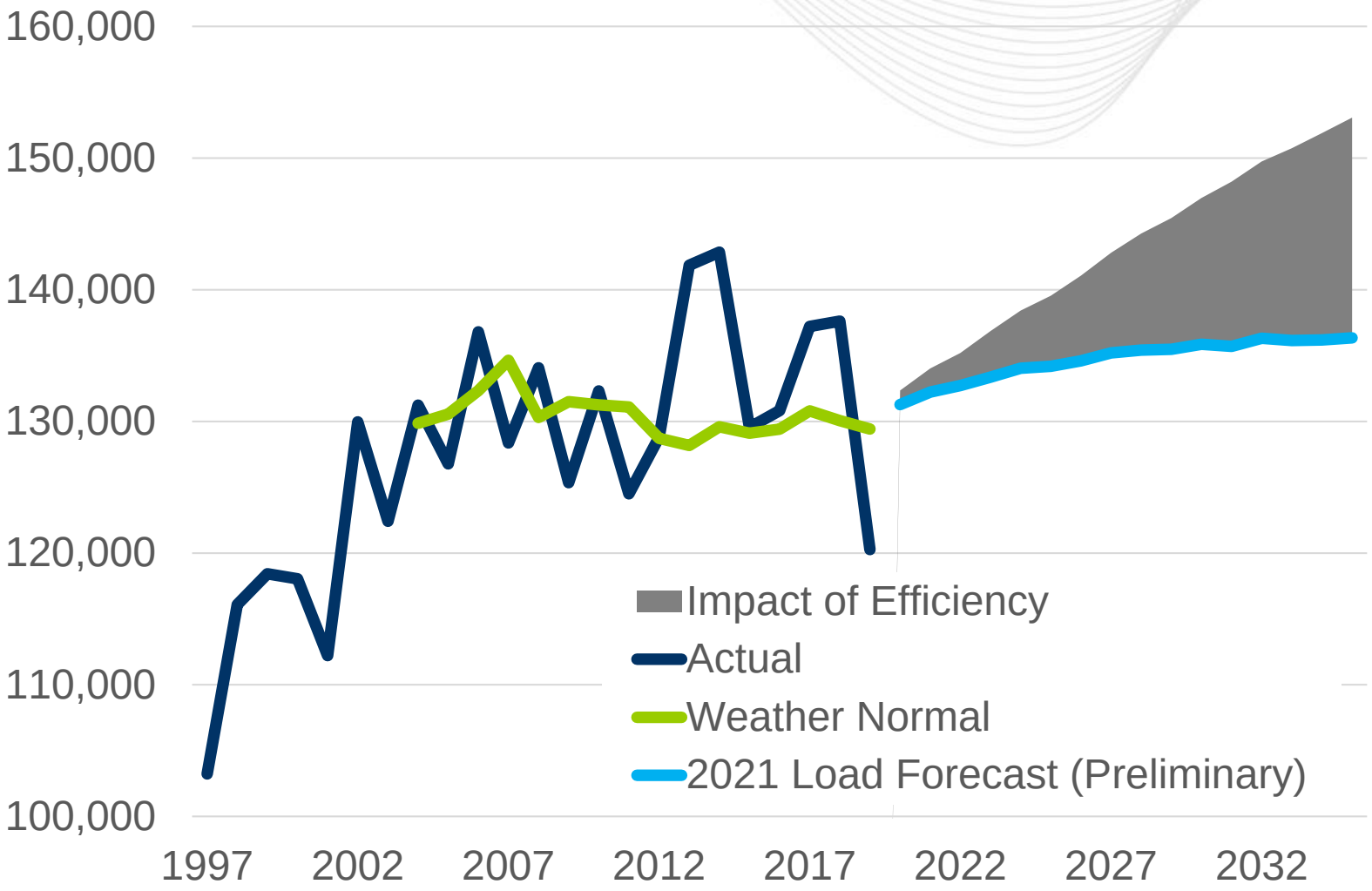
- 2021 Load Forecast used weather simulation of 1993-2019 to construct distribution compared with 1994-2018 in 2020 Load Forecast.
- Upper end of distribution is slightly higher with new forecast.

2021 PJM RTO Preliminary Winter Peak Forecast



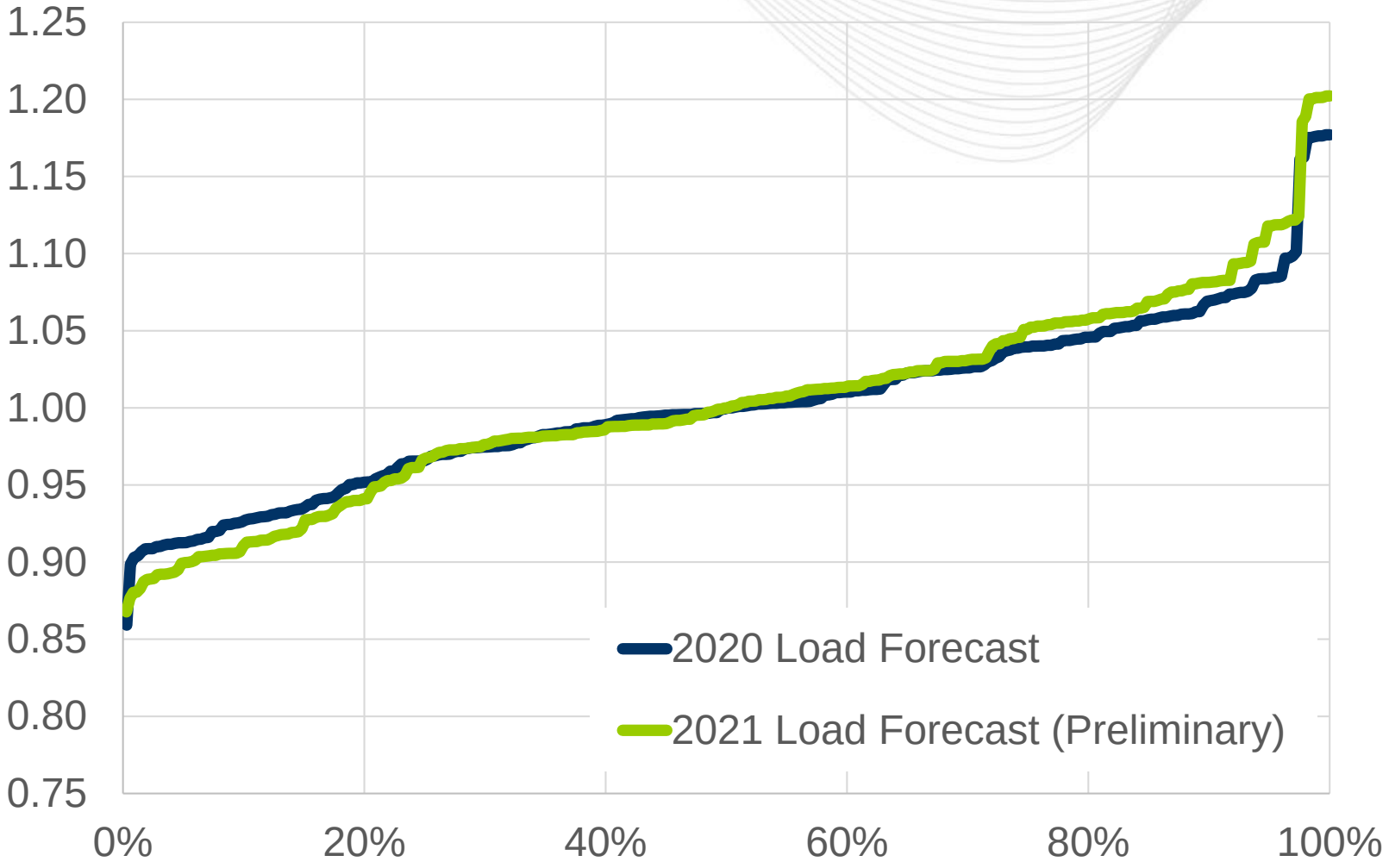
- 15-year Annualized Growth Rate
  - 2020 LF: 0.5%
  - 2021 LF: 0.3%
- Select year comparisons (2021 LF vs 2020LF)
  - 2023: Down 1.8%
  - 2025: Down 2.3%
  - 2034: Down 3.8%

Impact to Winter Forecast from Energy Efficiency



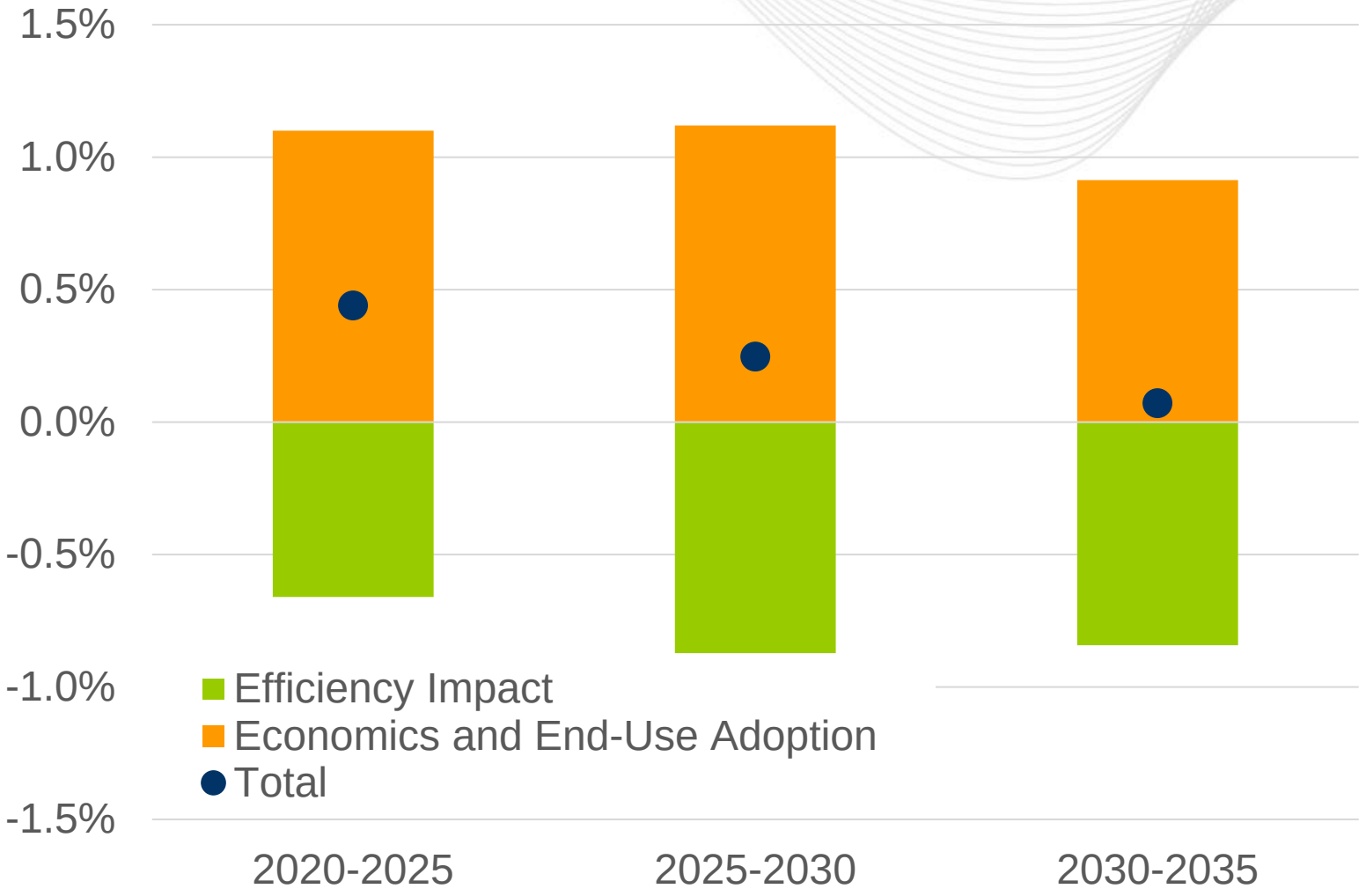
- Efficiency offsets load growth from economic and end-use adoption. Solar is assumed to not impact the Winter peak.
- Without this trend 15-year average load growth would be 0.7 percentage points faster (1% vs 0.3%).

2023 Winter Peak Distribution
50/50 equals 1.0



- 2021 Load Forecast used weather simulation of 1993-2019 to construct distribution compared with 1994-2018 in 2020 Load Forecast.
- Upper end of distribution is higher with new forecast. 90th percentile is 1.08 compared with 1.07 previously.

Winter Forecast Annualized Growth Contributions



- Early part of forecast horizon influenced by economic recovery.
  - Relatively large economic contributions
- No solar impacts, but larger efficiency impacts in heating period than cooling.
  - Efficiency data points to significant building shell improvements.

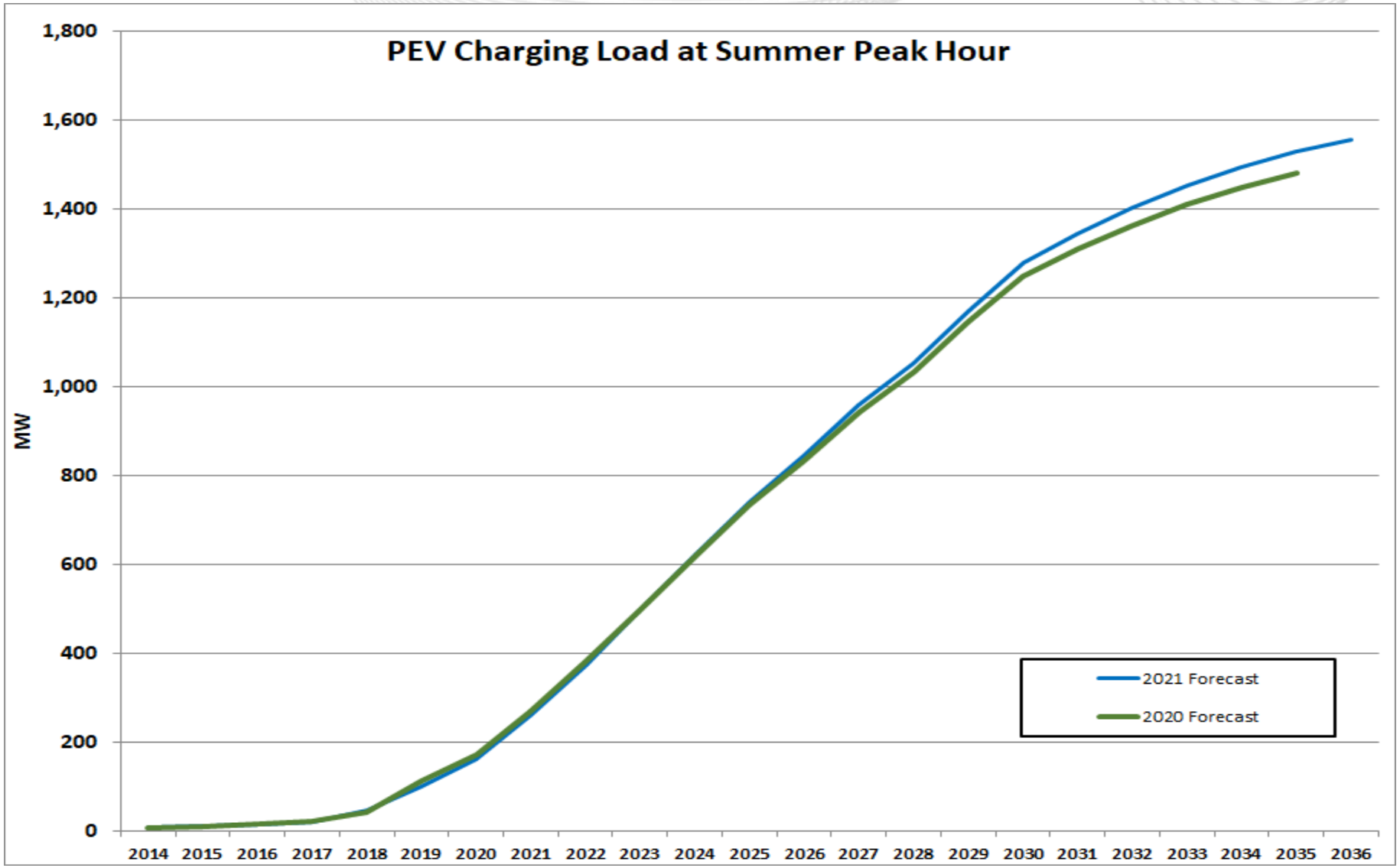
PEV Forecast

- The 2020 Annual Energy Outlook assumed the removal of California's ZEV Mandate, which significantly lowered the PEV sales forecast. The ZEV mandate required manufacturers to produce a specified number of electric and plug-in hybrids. Ten other States had also adopted the mandate.

- Given that there is a significant likelihood the ZEV Mandate will be restored, PJM is using the PEV sales forecast from the 2019 AEO for the 2021 forecast.

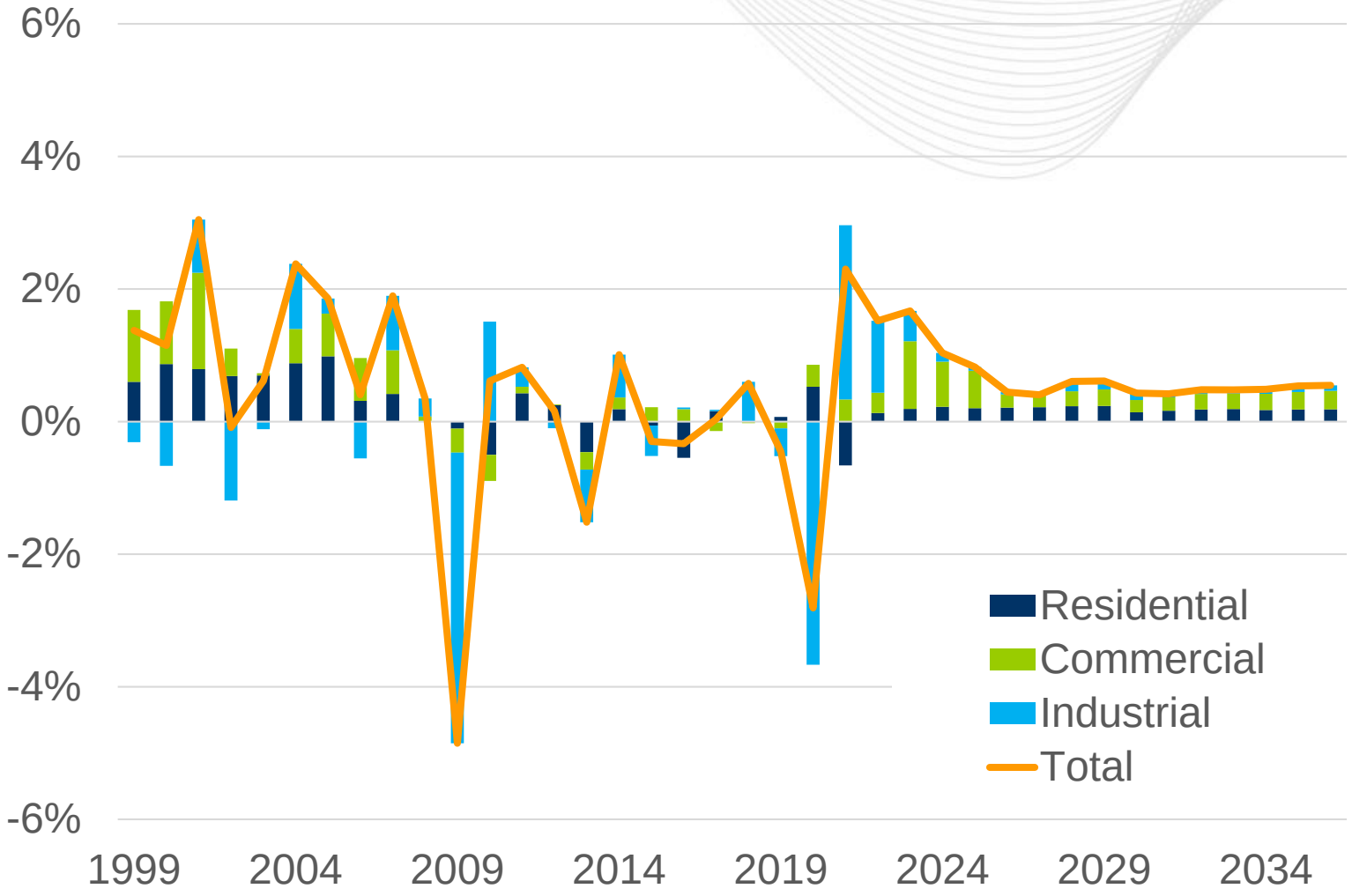
- This does not have a meaningful impact on the forecast.

PEV Forecast – Peak



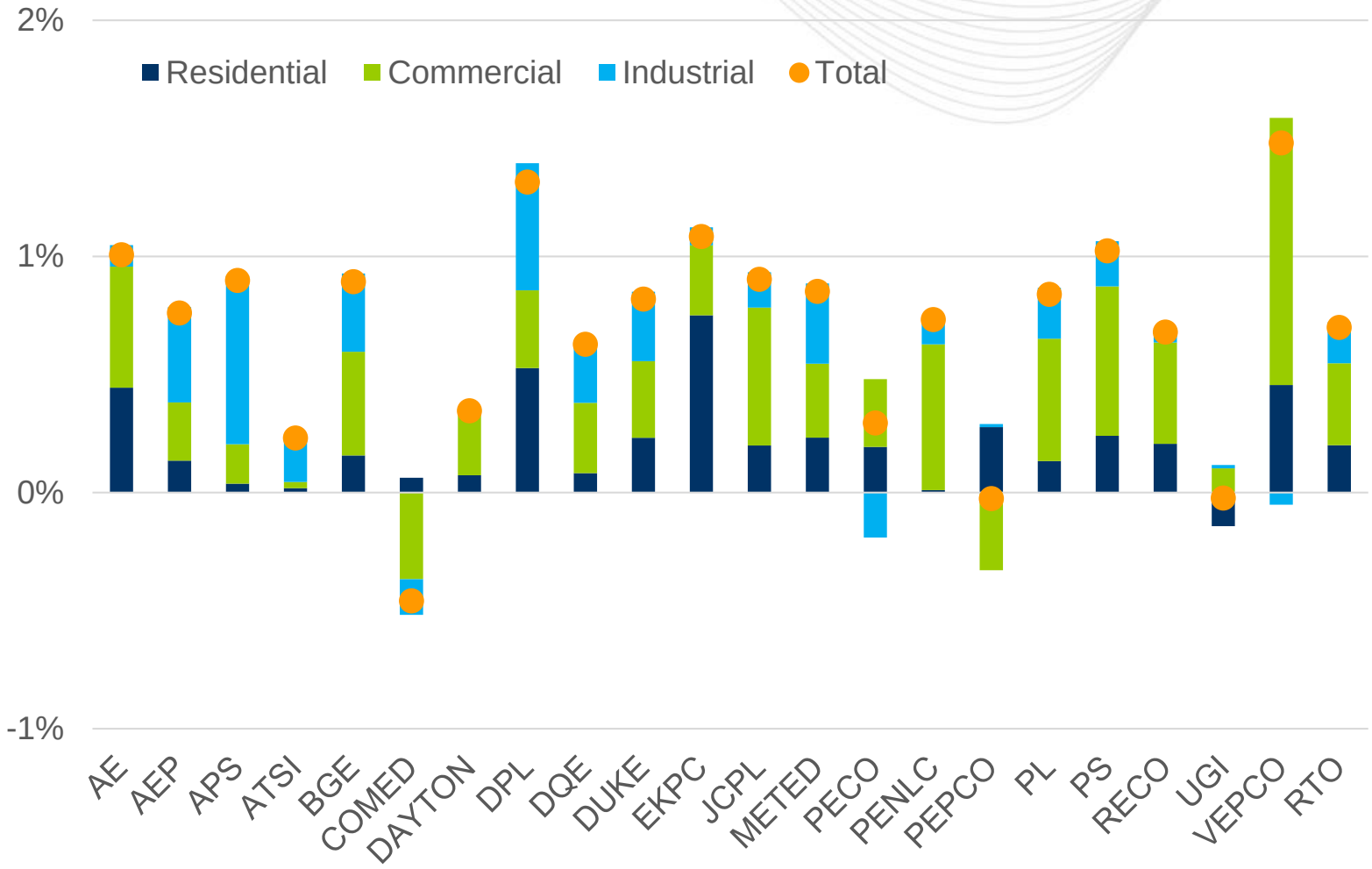
Drivers

PJM RTO Sector Growth Decomposition



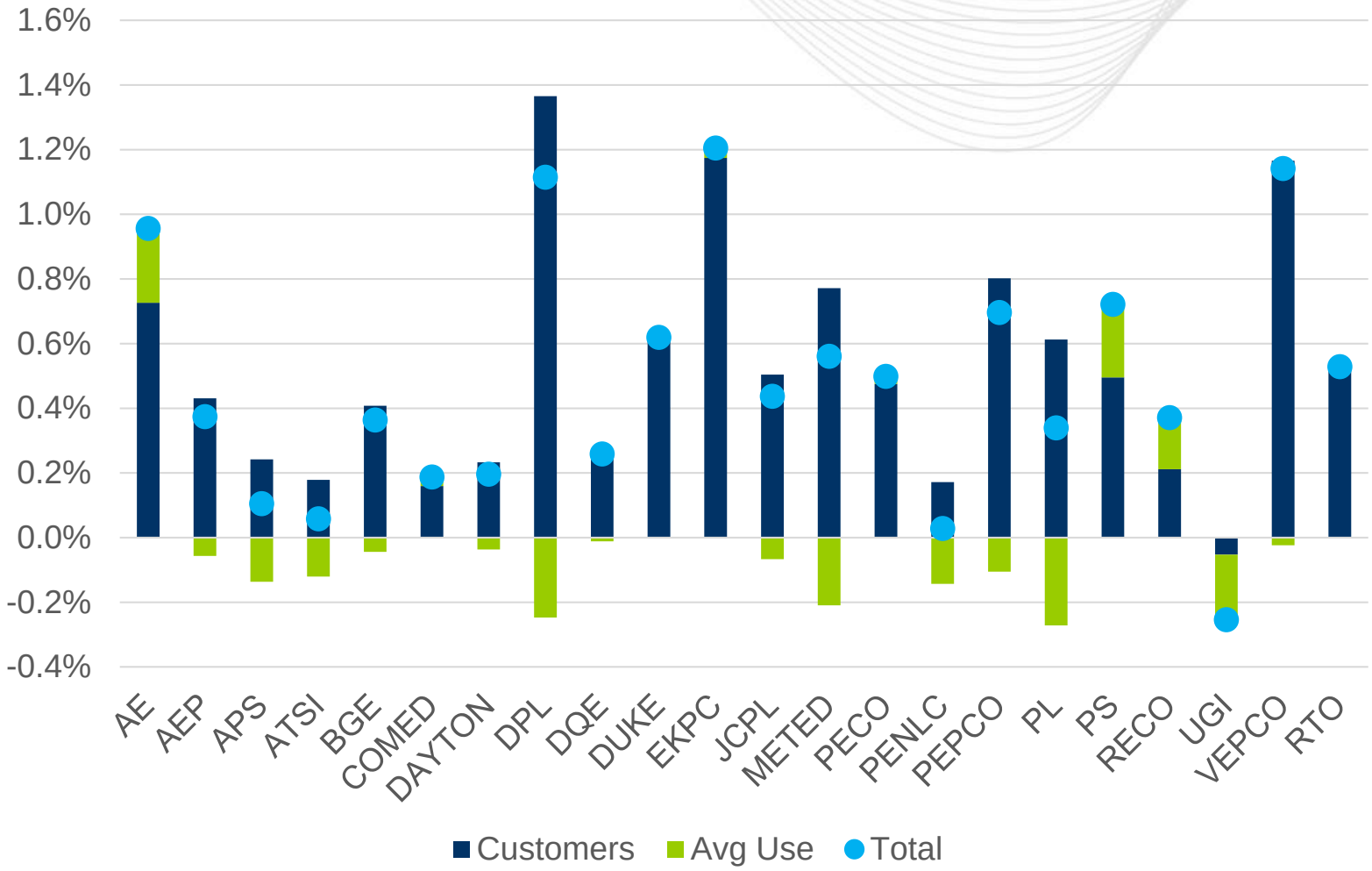
- This reflects gross demand from sector models (prior to reduction for solar).
- Early part of forecast horizon influenced by economic recovery.
  - Relatively large economic contributions due to industrial output and employment recoveries
- Long run driven by small growth in residential and commercial sectors.

Sector Annualized Growth Decomposition (2021 - 2036)



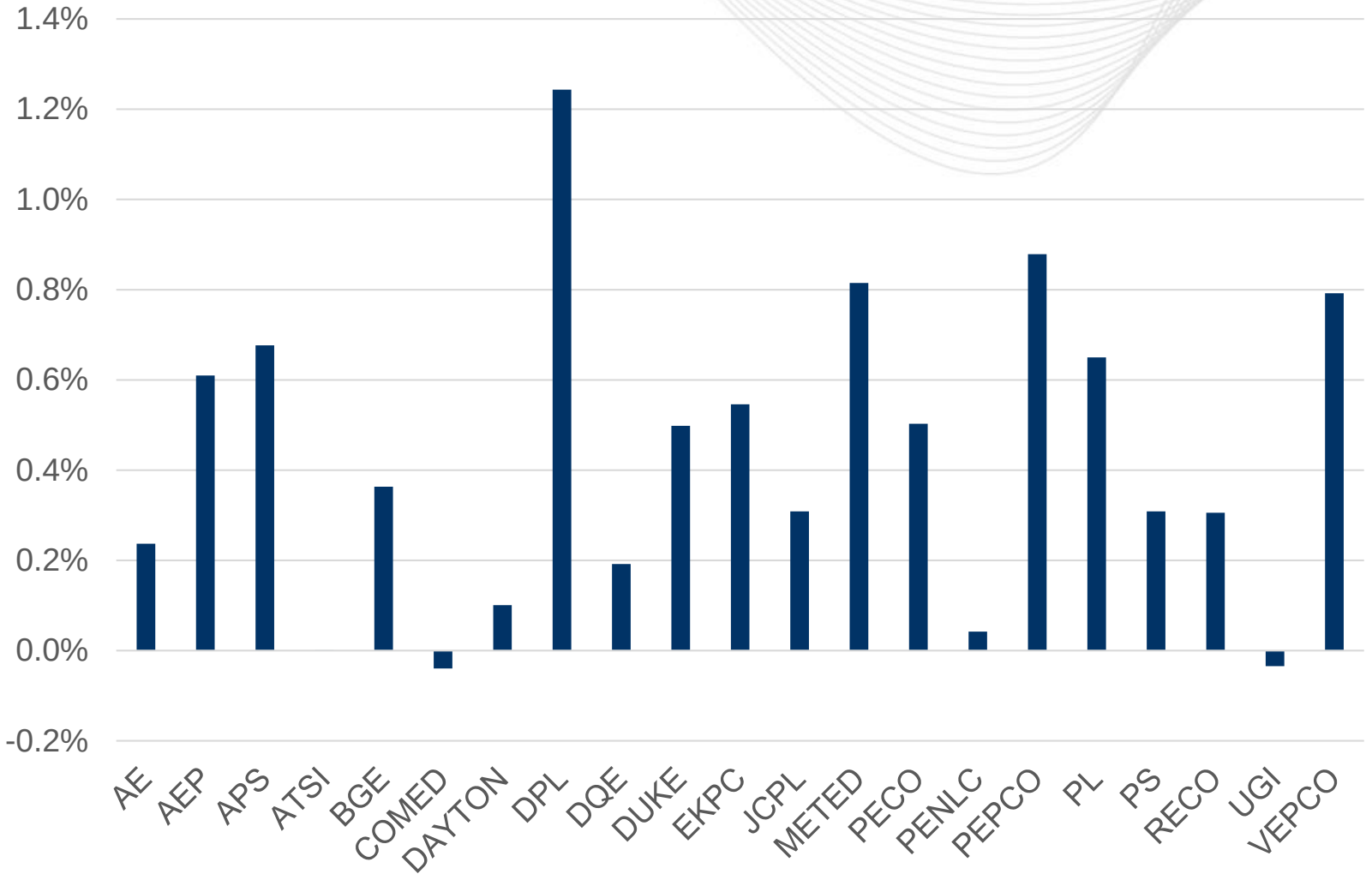
- This reflects gross demand from sector models (prior to reduction for solar).
- Some positive impact on growth rates due to recovery period.
- Most zones see positive contributions from residential and commercial sectors.

Residential Annualized Growth Breakdown (2021-2036)



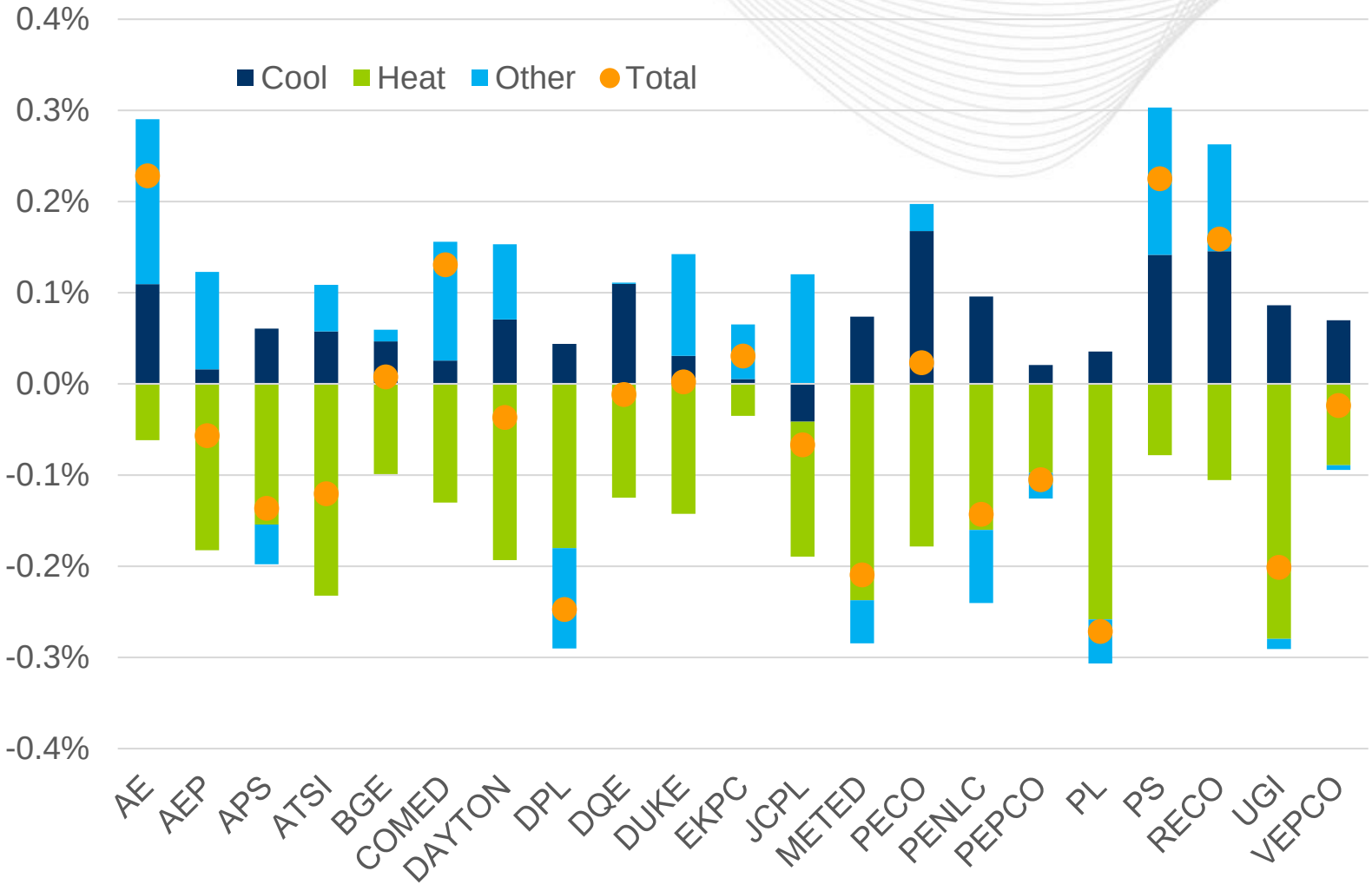
- This reflects gross demand from sector models (prior to reduction for solar).
- Customer growth is expected to be positive for most zones, contributing 0.5 percentage points on average.
- Average use growth is generally a smaller factor, with an average contribution of 0 percentage points.

Residential Customer Economics – Households Annualized Growth (2021-2036)



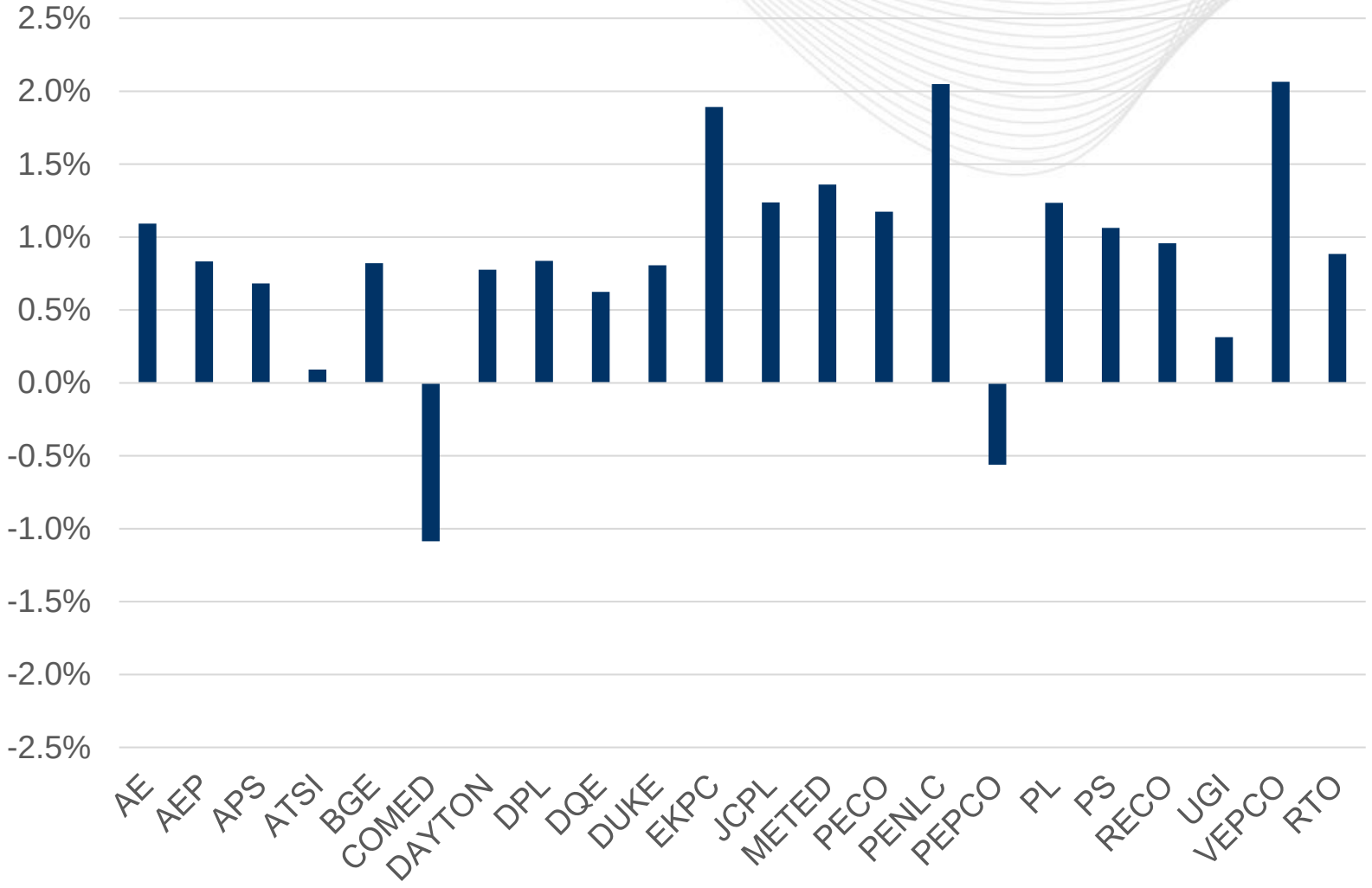
- Residential customers model is driven by households, an economic concept obtained from Moody's Analytics

Residential Average Use Annualized Growth (2021-2036)



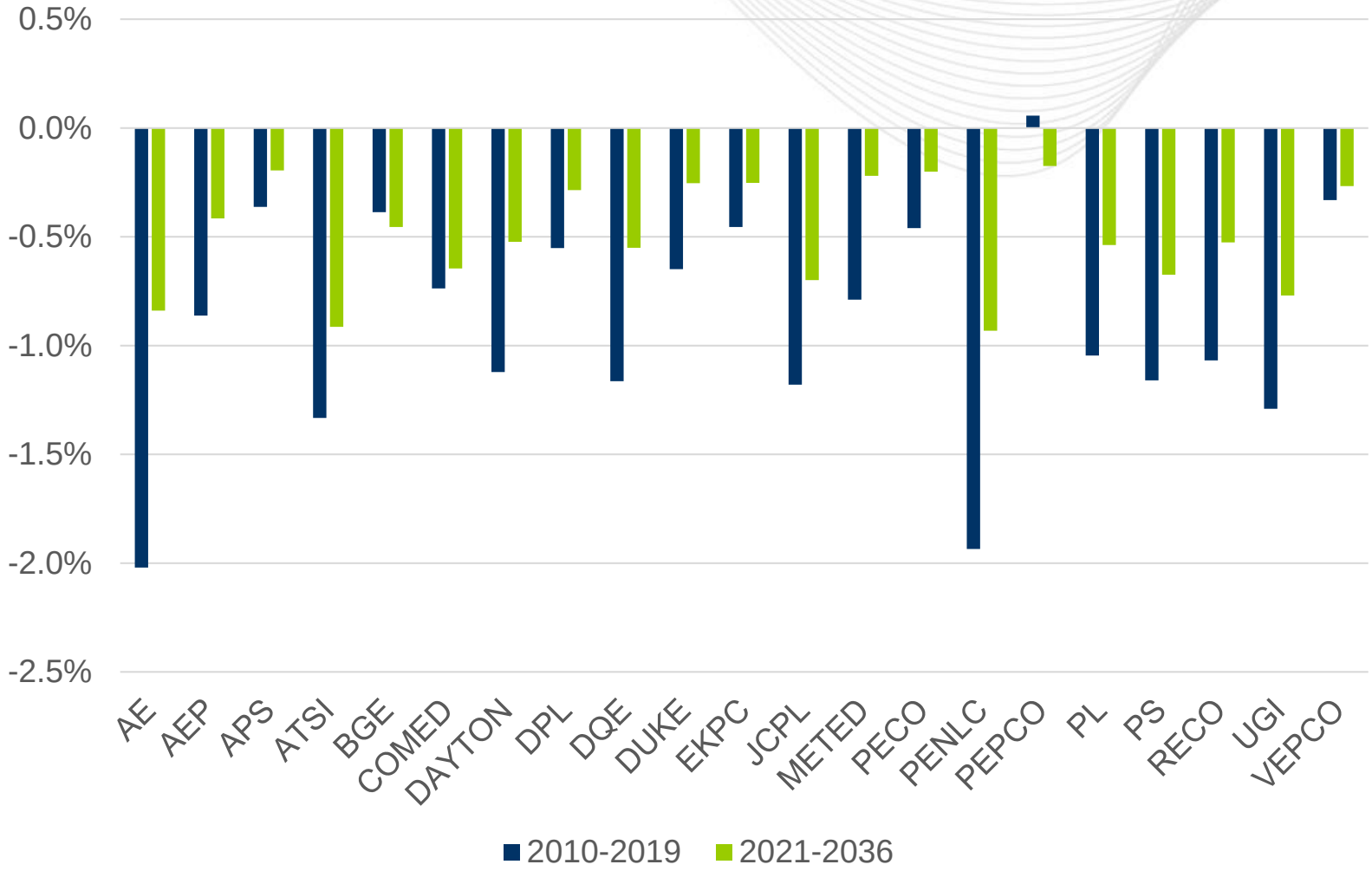
- Residential average use model is driven by:
  - End-use saturation and efficiency trends (provided by Itron)
  - Real per household income and Household size (provided by Moody's Analytics)

Commercial Annualized Growth (2021-2036)



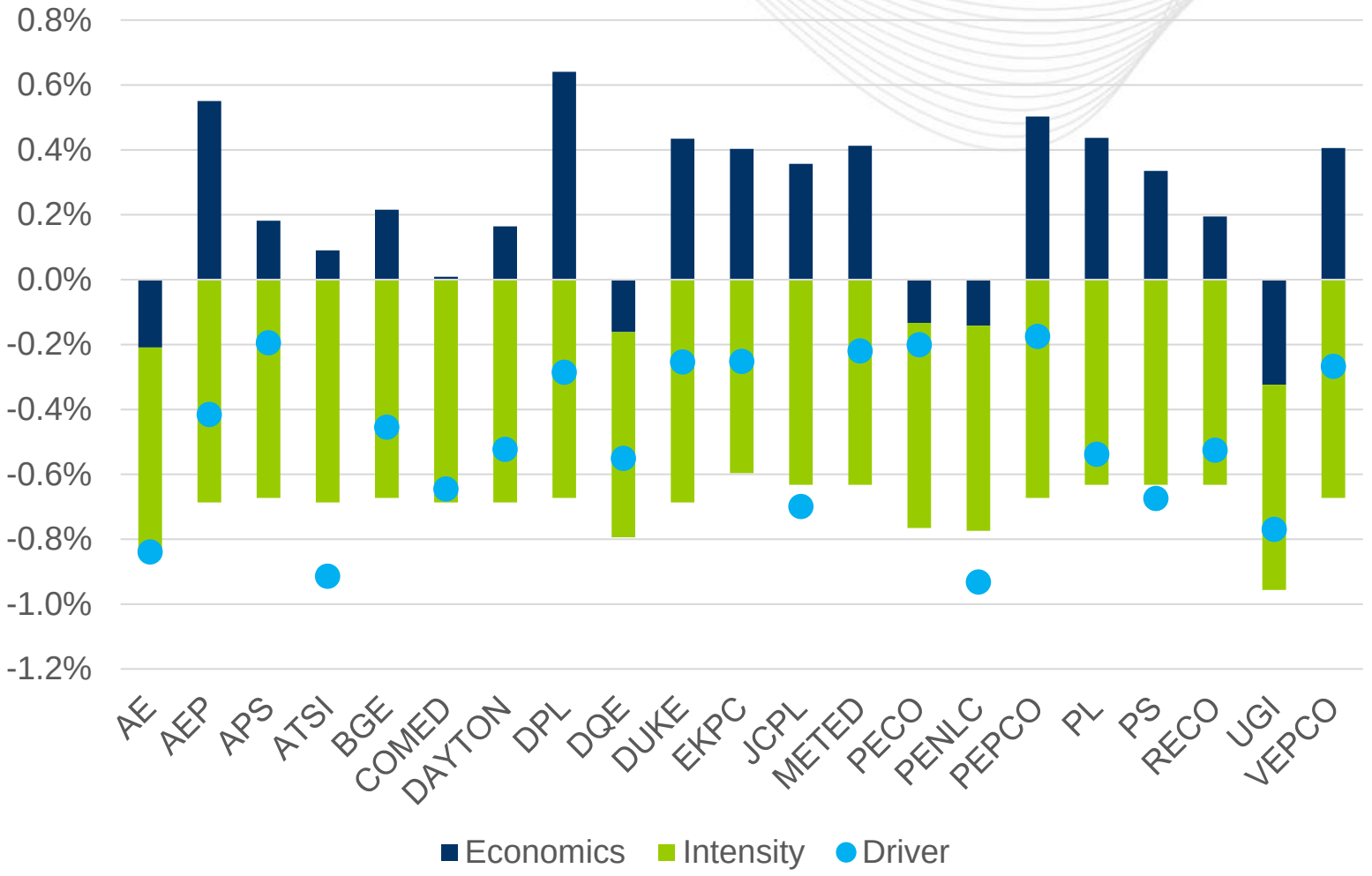
- This reflects gross demand from sector models (prior to reduction for solar).
- Commercial model is driven by:
  - End-use saturation and efficiency trends (provided by Itron)
  - Weighted economic variable of working-age population and service sector employment (provided by Moody's Analytics)

Commercial Driver Growth – Time Period Comparison Annualized Growth



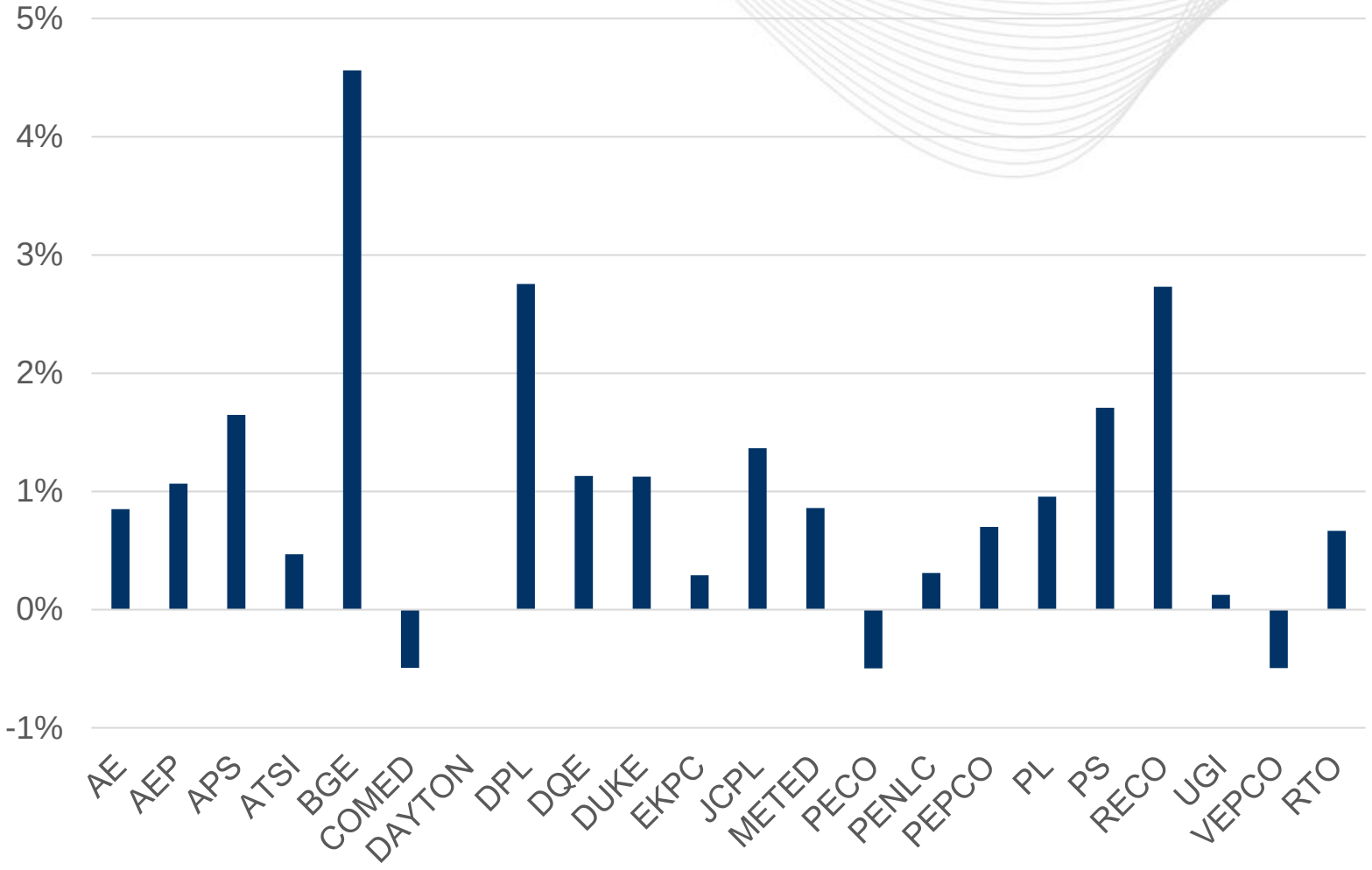
- Commercial model is calibrated to the driver variable (combination of end-use saturation/efficiency and economics).
- Growth in Commercial demand reflects the more positive outlook for the driver variable.

Commercial Driver Decomposition Annualized Growth (2021-2036)



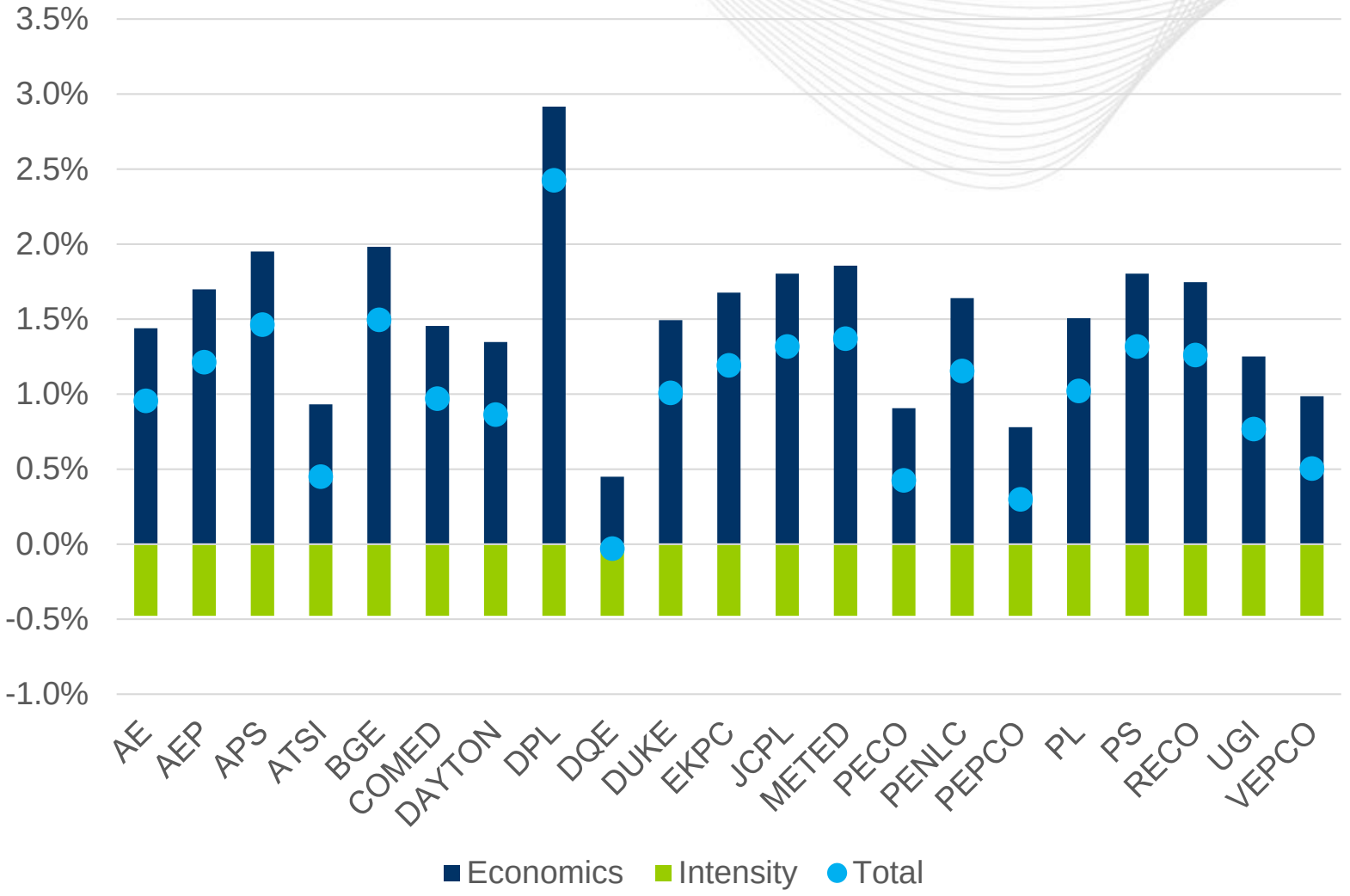
- Commercial Intensity is use per square foot (measured in kwh), and is a function of end-use saturation and efficiency trends.
- Commercial Economics is a weighted index of working-age population and service-sector employment.

Industrial Annualized Growth (2021-2036)



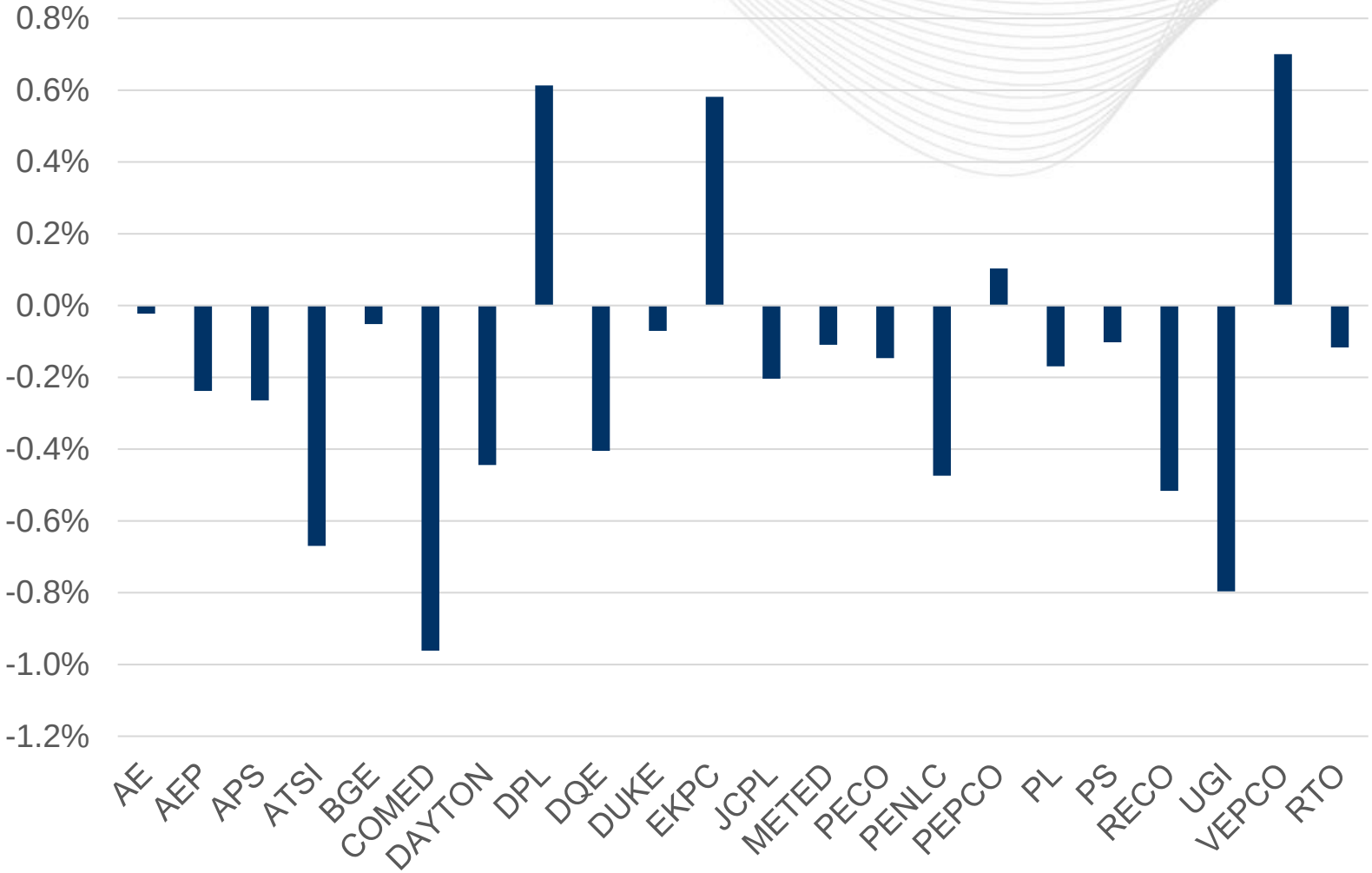
- This reflects gross demand from sector models (prior to reduction for solar).
- Industrial model is driven by:
  - Real industrial output (Moody's Analytics)
  - Industrial intensity (EIA)

Industrial Driver Decomposition Annualized Growth (2021-2036)



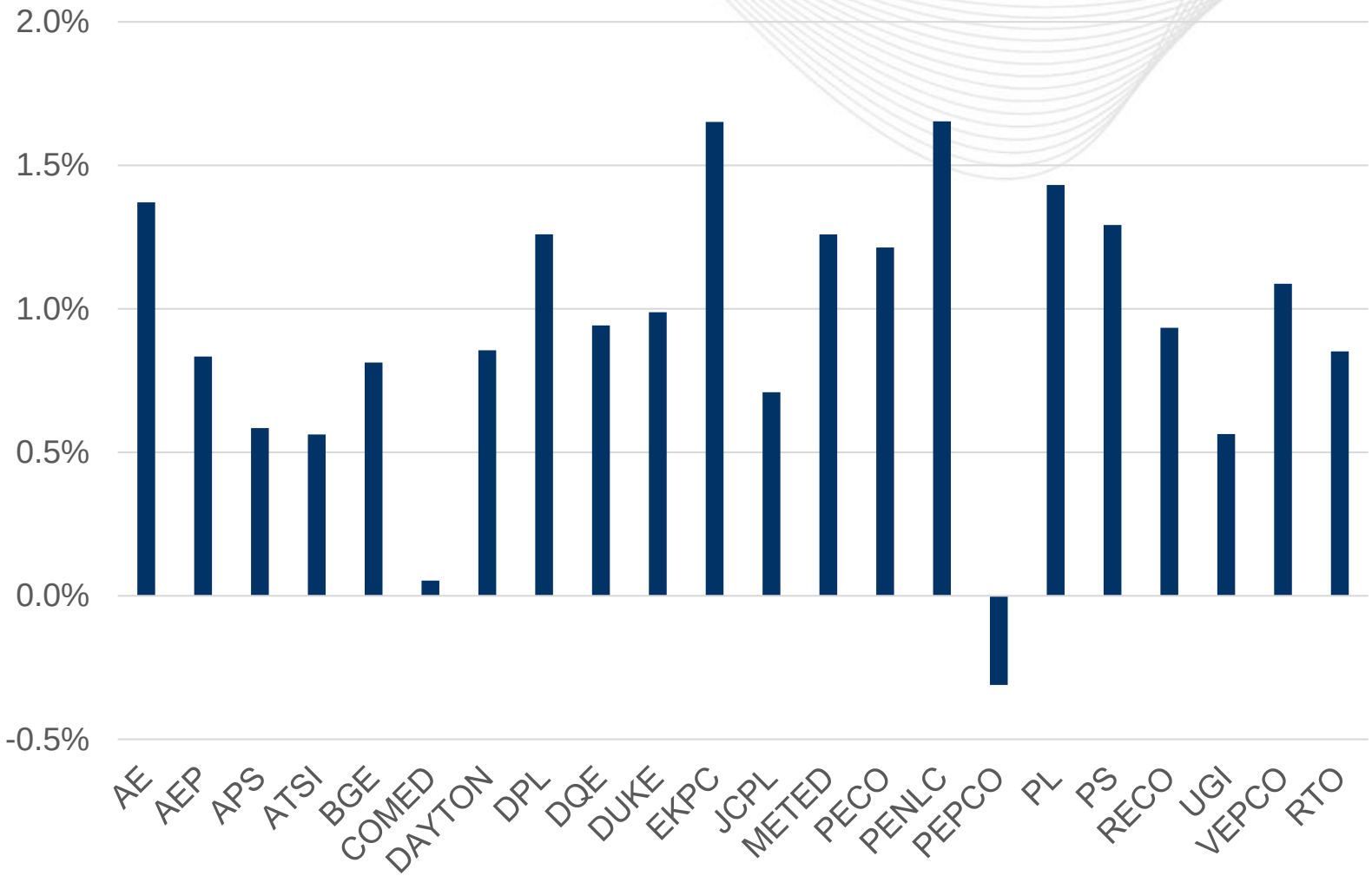
- Industrial Economics is Real Industrial Output
- Intensity is electricity use per real output

Heating End-Use Index Annualized Growth (2021-2036)



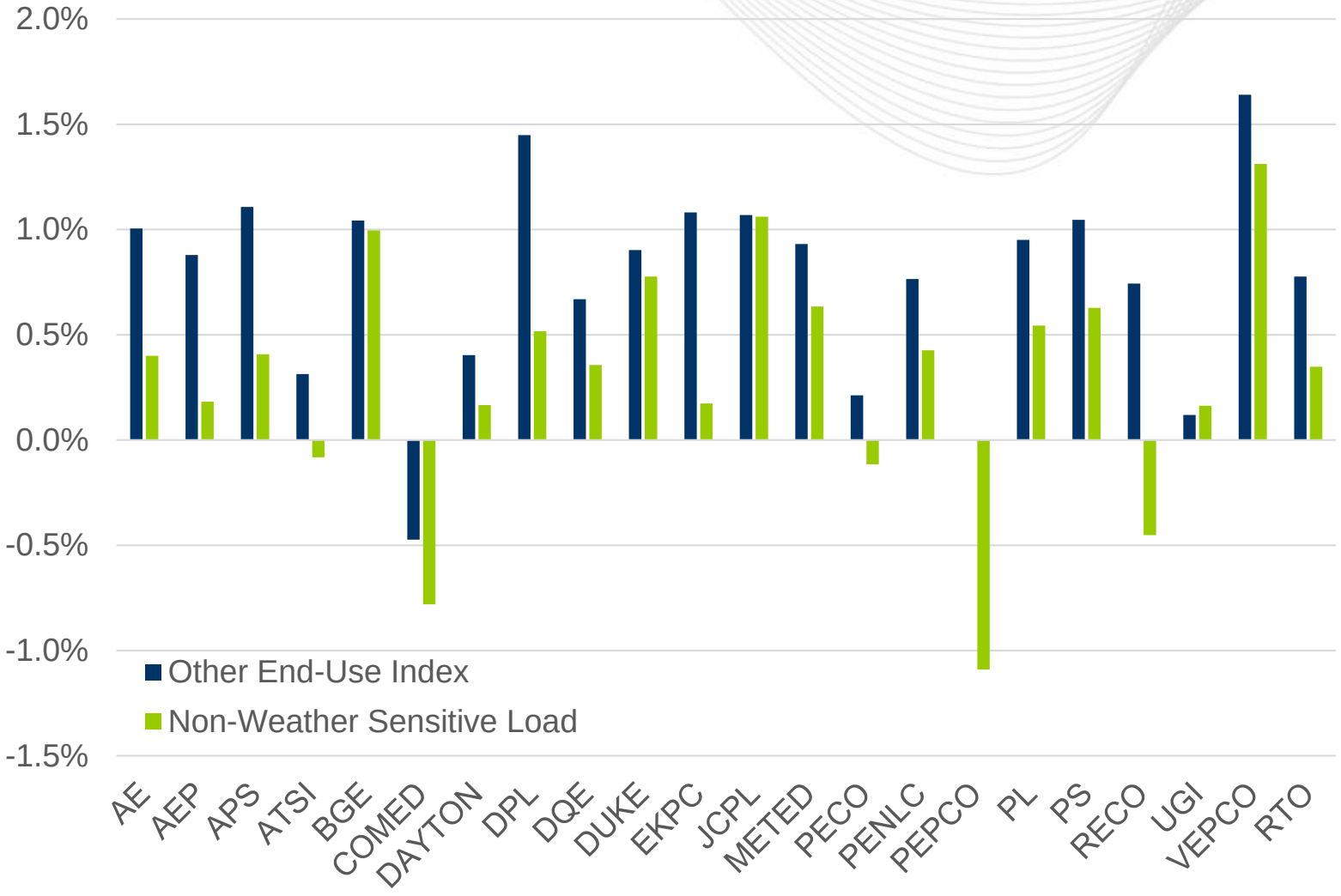
- Heating is a function of Residential Heating and Commercial Heating
- Heating is primarily Residential, and so trends are largely reflective of the balance of residential customer growth relative to usage trends.
- Accounts for significant improvements in building shell efficiency.

Cooling End-Use Index Annualized Growth (2021-2036)



- Cooling is a function of Residential Cooling and Commercial Cooling
- Cooling tends to be slightly more Residential driven. Trends reflect relative economic growth and cooling end-use trends.
- Some zones have noticeable gains in A/C saturation.
- Building shell efficiency gains are not as significant for cooling as for heating.

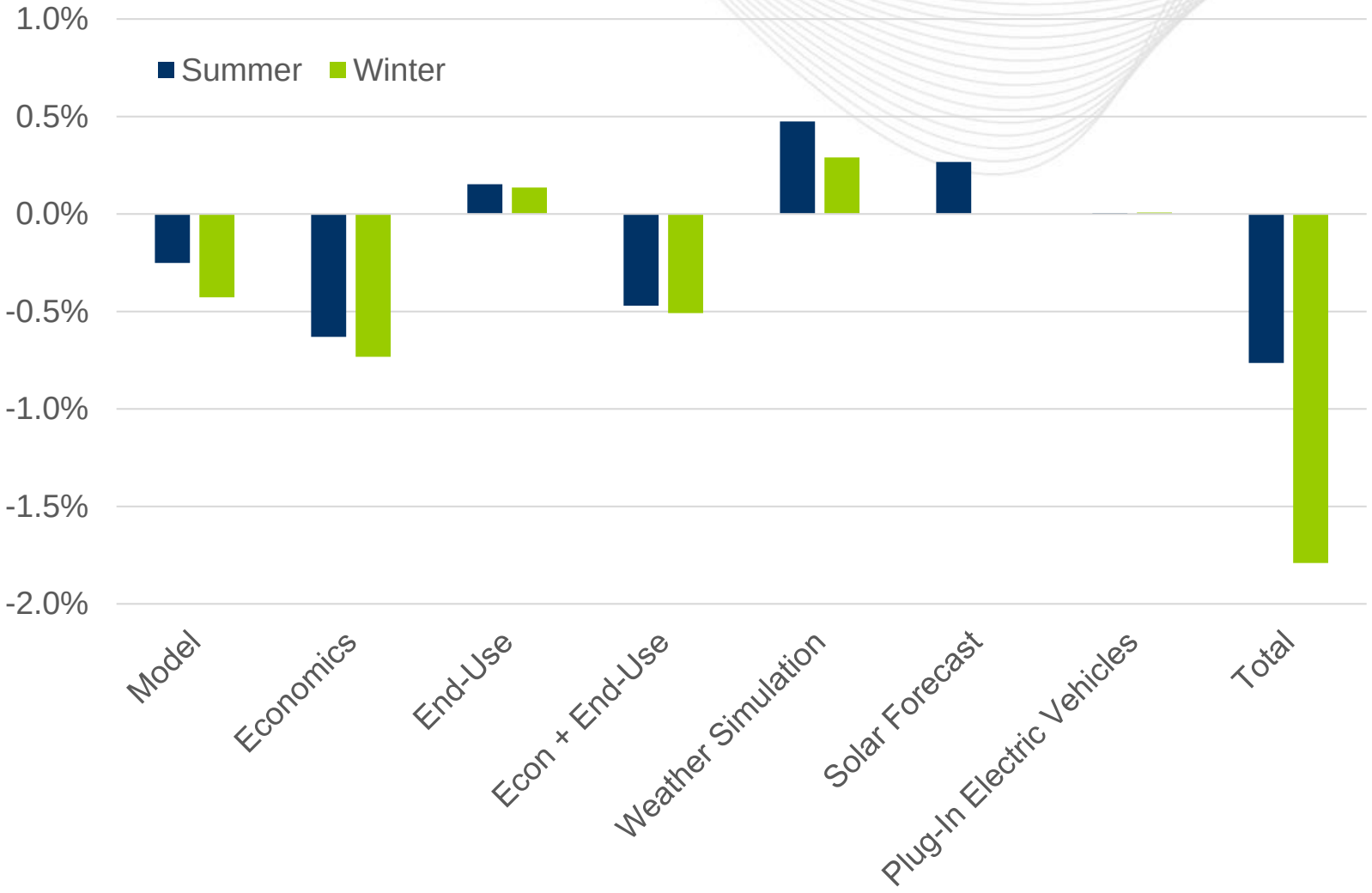
Other End-Use Index and Non-Weather Sensitive Load Annualized Growth (2021-2036)



- Other is a function of Residential Other, Commercial Other, and Industrial.
- Other does not directly impact the model, but rather is used as an input to determining non-weather sensitive load.

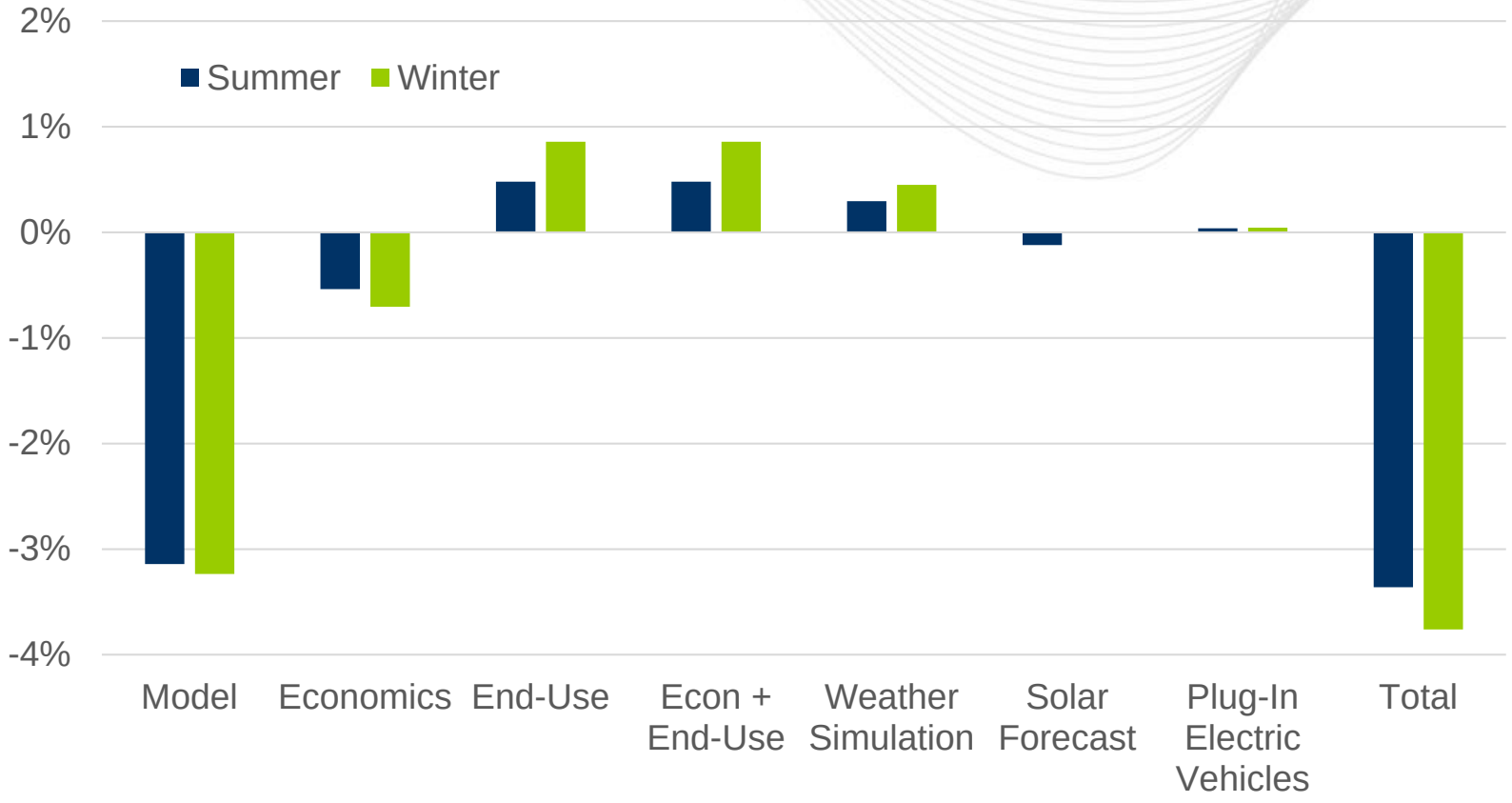
Year-to-Year Factors of Change

Impact of Changes in 2023 Delivery Year From 2020 Load Forecast to 2021 Load Forecast



- Changes were made to the model as well as the input variables.
- Factors that lowered the forecast
  - Model changes
  - New economic forecast
- Factors that raised the forecast
  - New end-use forecast
  - New weather simulation
  - New solar forecast

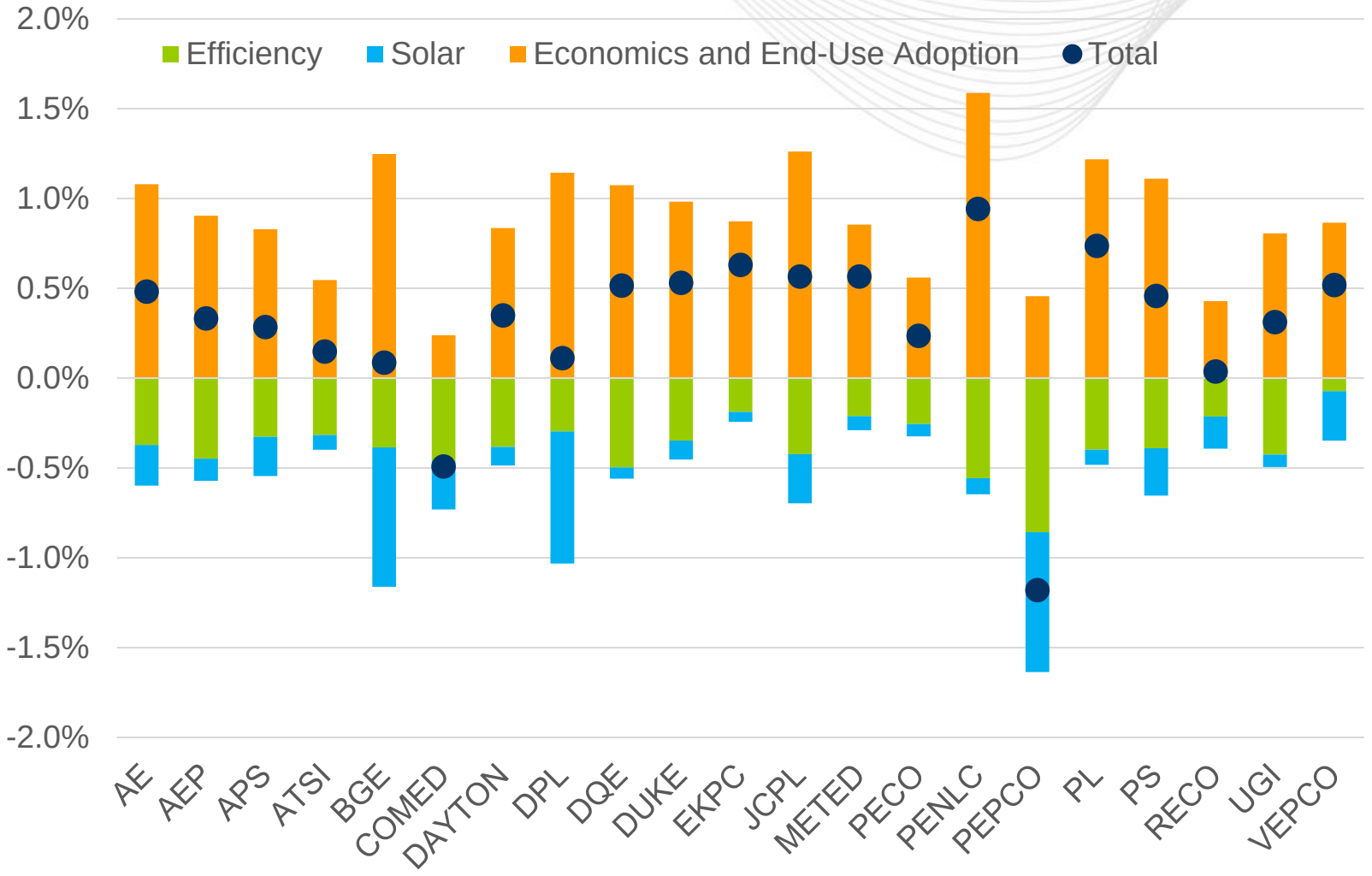
Impact of Changes in 2034 Delivery Year From 2020 Load Forecast to 2021 Load Forecast



- Changes were made to the model as well as the input variables.
- Factors that lowered the forecast
  - Model changes
  - New economic forecast
  - New solar forecast
- Factors that raised the forecast
  - New end-use forecast
  - New weather simulation

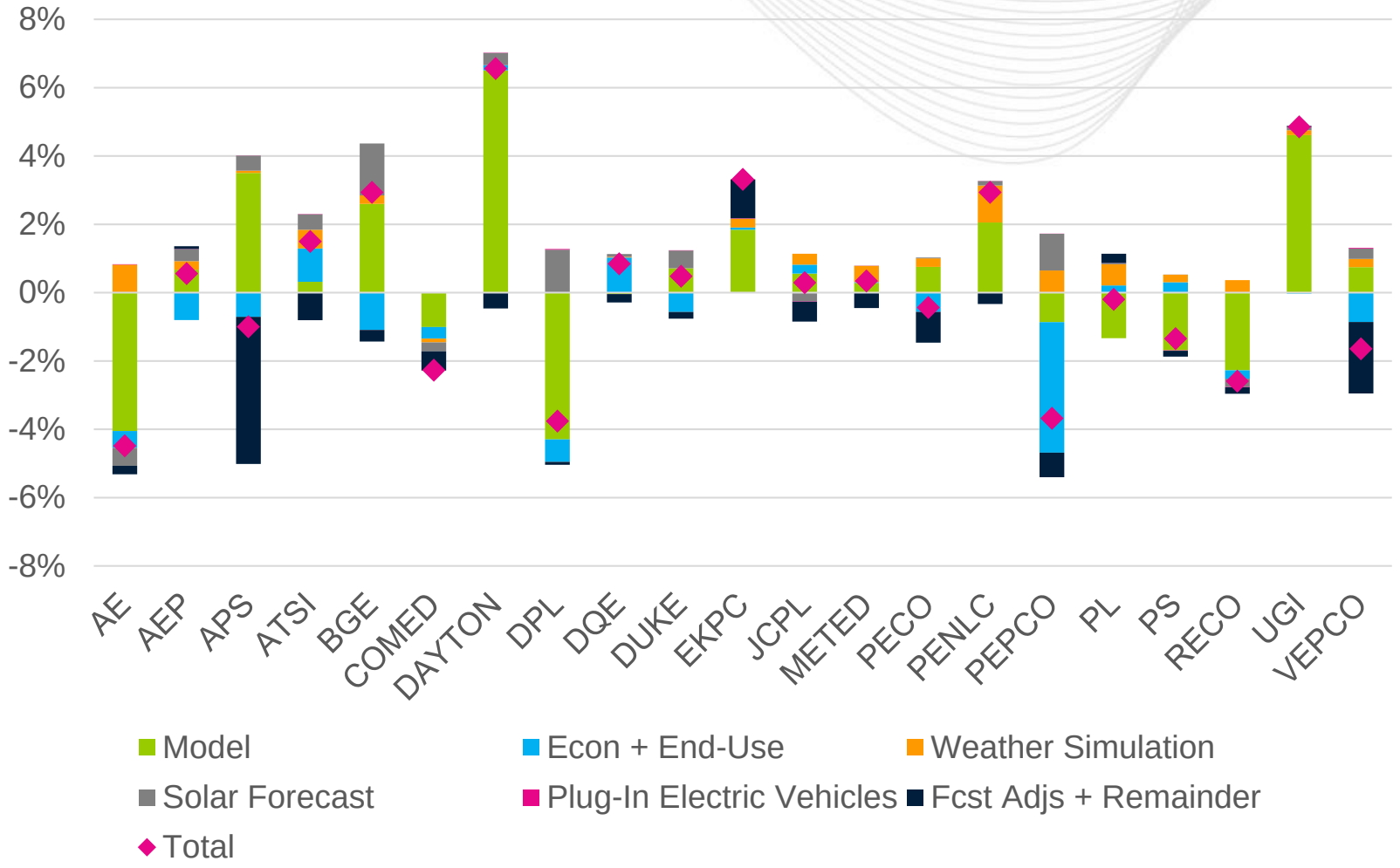
Zonal Summary

Summer Peak Forecast
Annualized Growth Contributions (2021-2036)



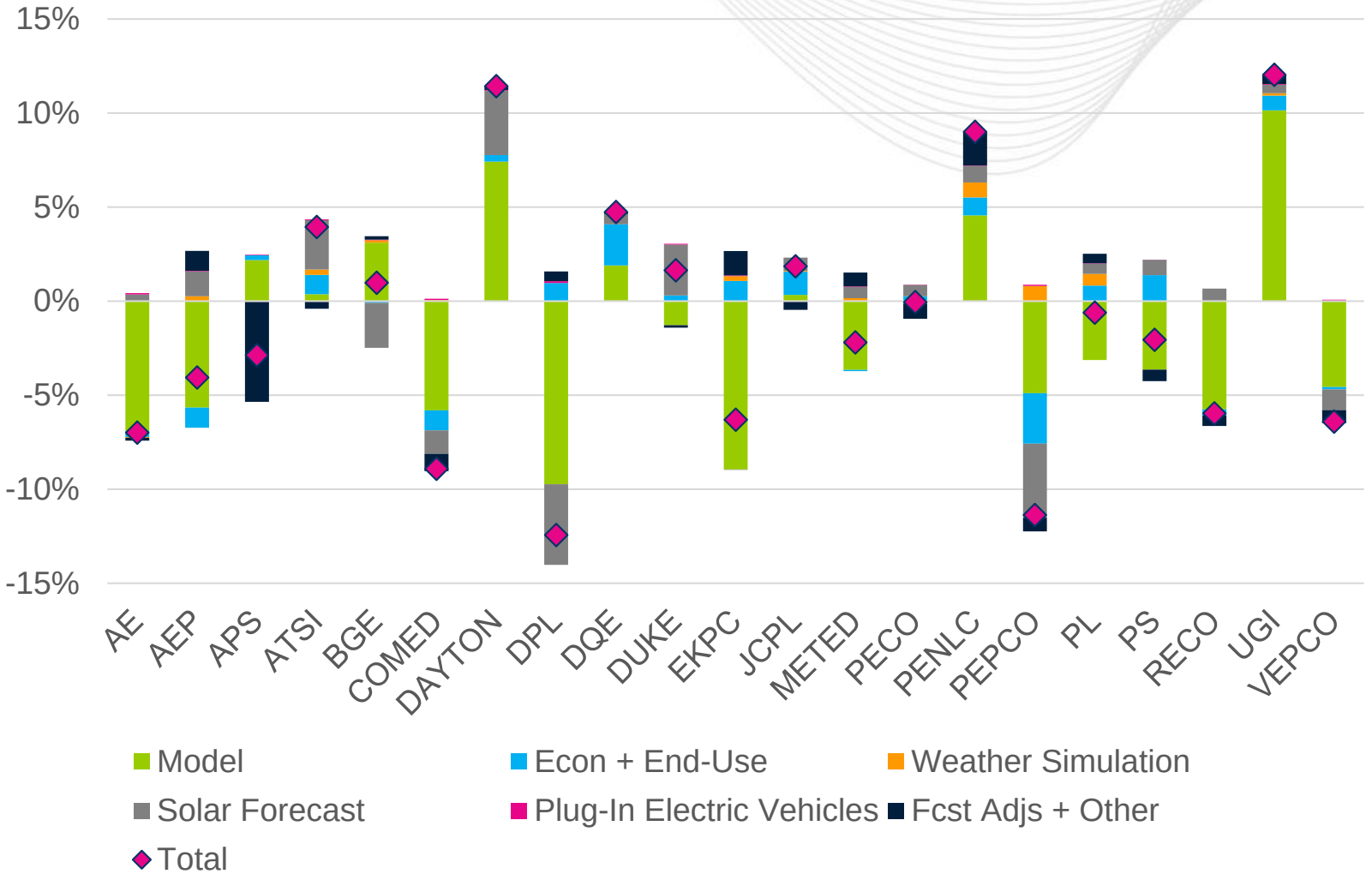
- Early part of forecast horizon influenced by economic recovery.
- Long run more modest economic and end-use adoption offset by solar and efficiency gains.

2023 Summer Peak Comparison- Preliminary 2021 Forecast vs 2020 Forecast



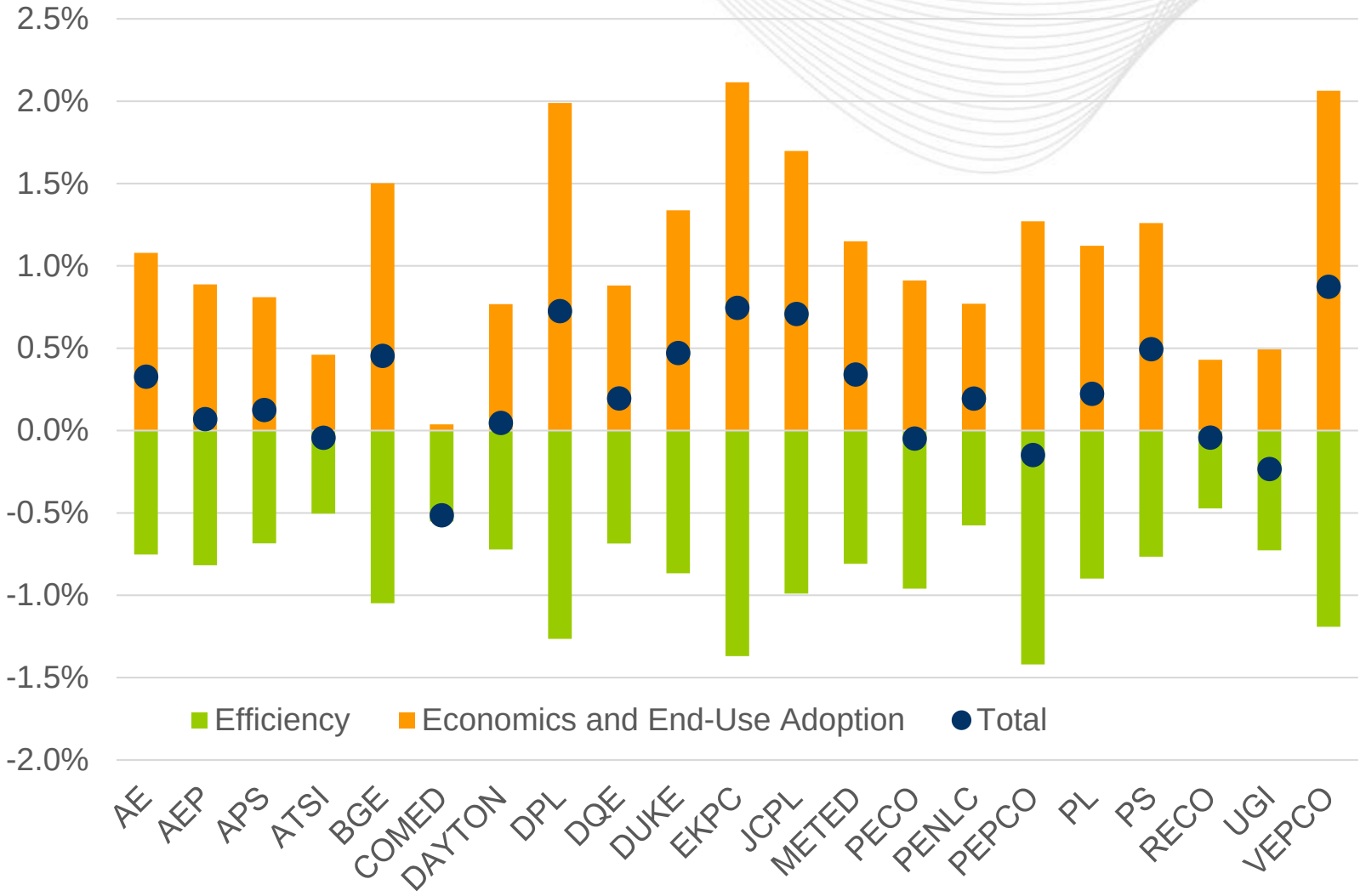
- Model changes are the largest contributor on a zonal basis, but plus and minus.
- Updating of economics and end-use were cumulatively negative for most zones.
- A more modest near-term solar forecast added in most zones.

2035 Summer Peak Comparison- Preliminary 2021 Forecast vs 2020 Forecast



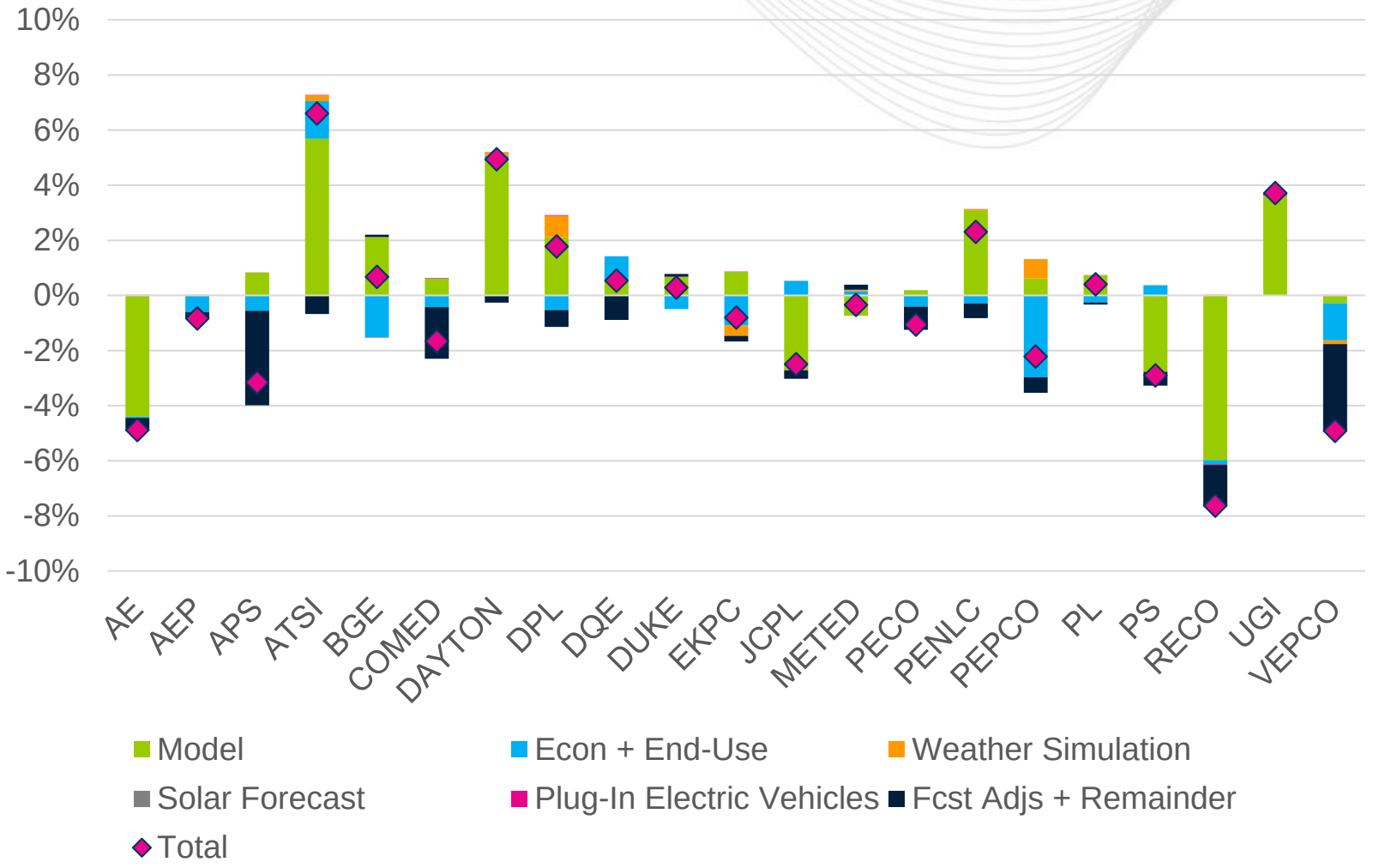
- Model changes are the largest contributor on a zonal basis, primarily negative.
- Updating of economics and end-use were mixed as recovery effects are muted in long-run.
- Long-term solar forecast is slightly higher (subtracts more from load).

Winter Peak Forecast
Annualized Growth Contributions (2021-2036)



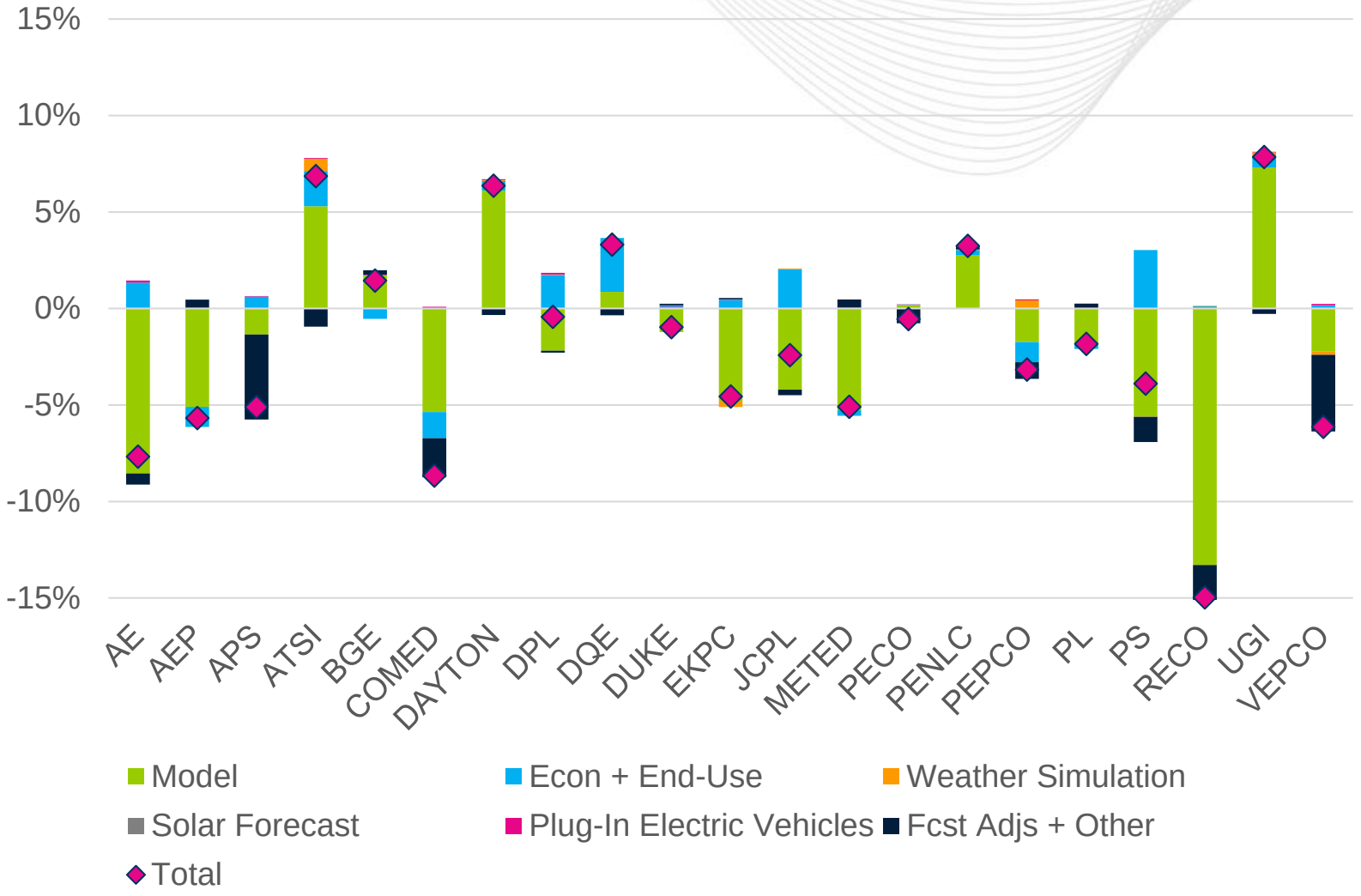
- Early part of forecast horizon influenced by economic recovery.
- Long run more modest economic and end-use adoption offset by efficiency gains.
- Winter peak forecast not impacted by solar.

2023 Winter Peak Comparison- Preliminary 2021 Forecast vs 2020 Forecast



- Model changes are the largest contributor on a zonal basis, but plus and minus.
- Updating of economics and end-use were cumulatively negative for most zones.

2034 Winter Peak Comparison- Preliminary 2021 Forecast vs 2020 Forecast



- Model changes are the largest contributor on a zonal basis, but plus and minus.
- Updating of economics and end-use were mixed as recovery effects are muted in long-run.

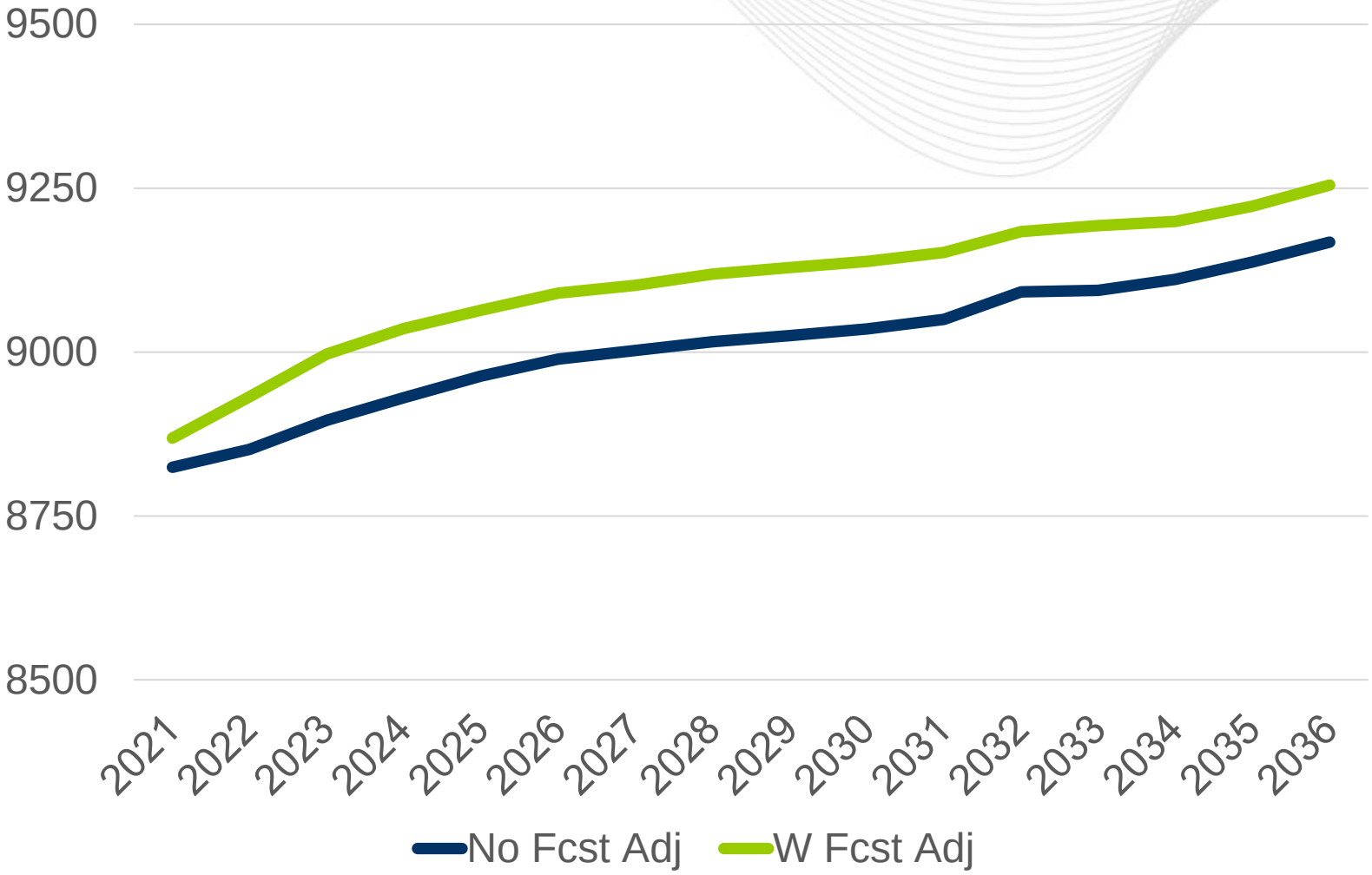
Forecast Adjustments

Forecast Adjustments

- EDCs are encouraged to provide PJM with information about large changes that may not be captured in the forecast process.

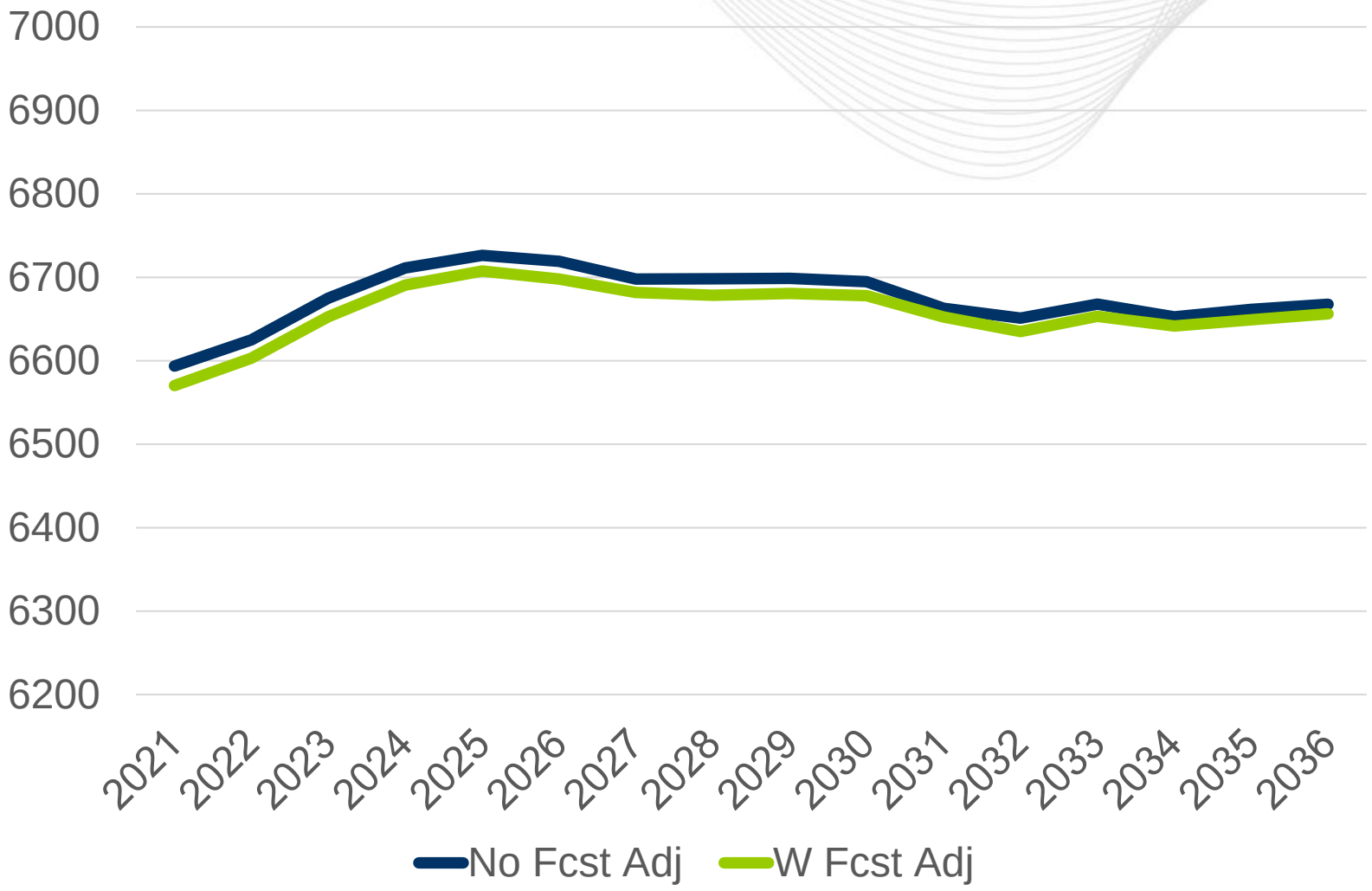
- PJM evaluates and incorporates using the sector models. We view requests through the lens of:
  - Is the request significant?
  - Is there risk of double counting?
    - Is the trend likely captured in the economic forecast?
    - Can the trend be removed from the history?

APS



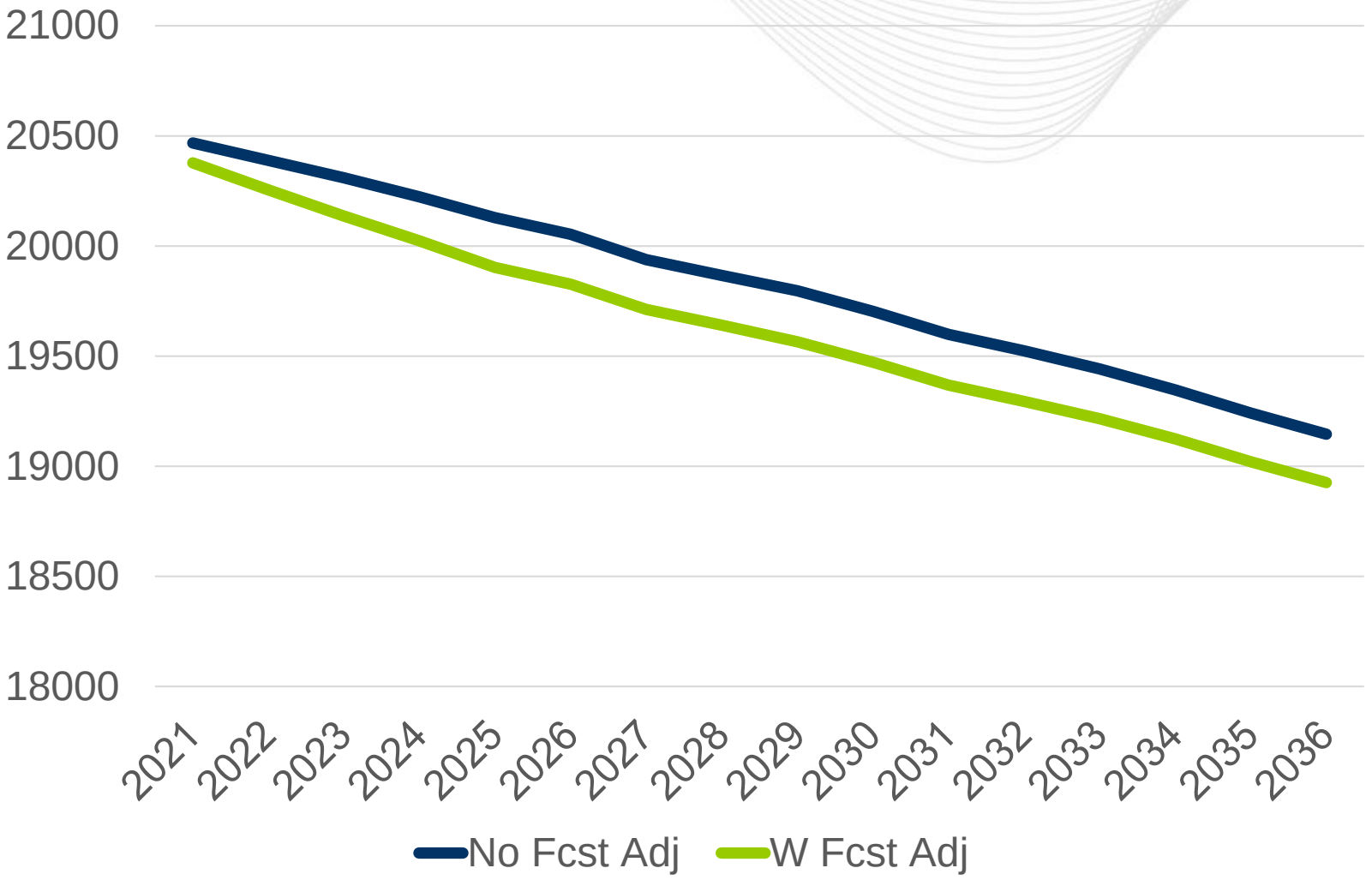
- Request related to fracking development.
- Captured in the Industrial sector.
- Has an impact of plus 50 to 100 MWs.

BGE



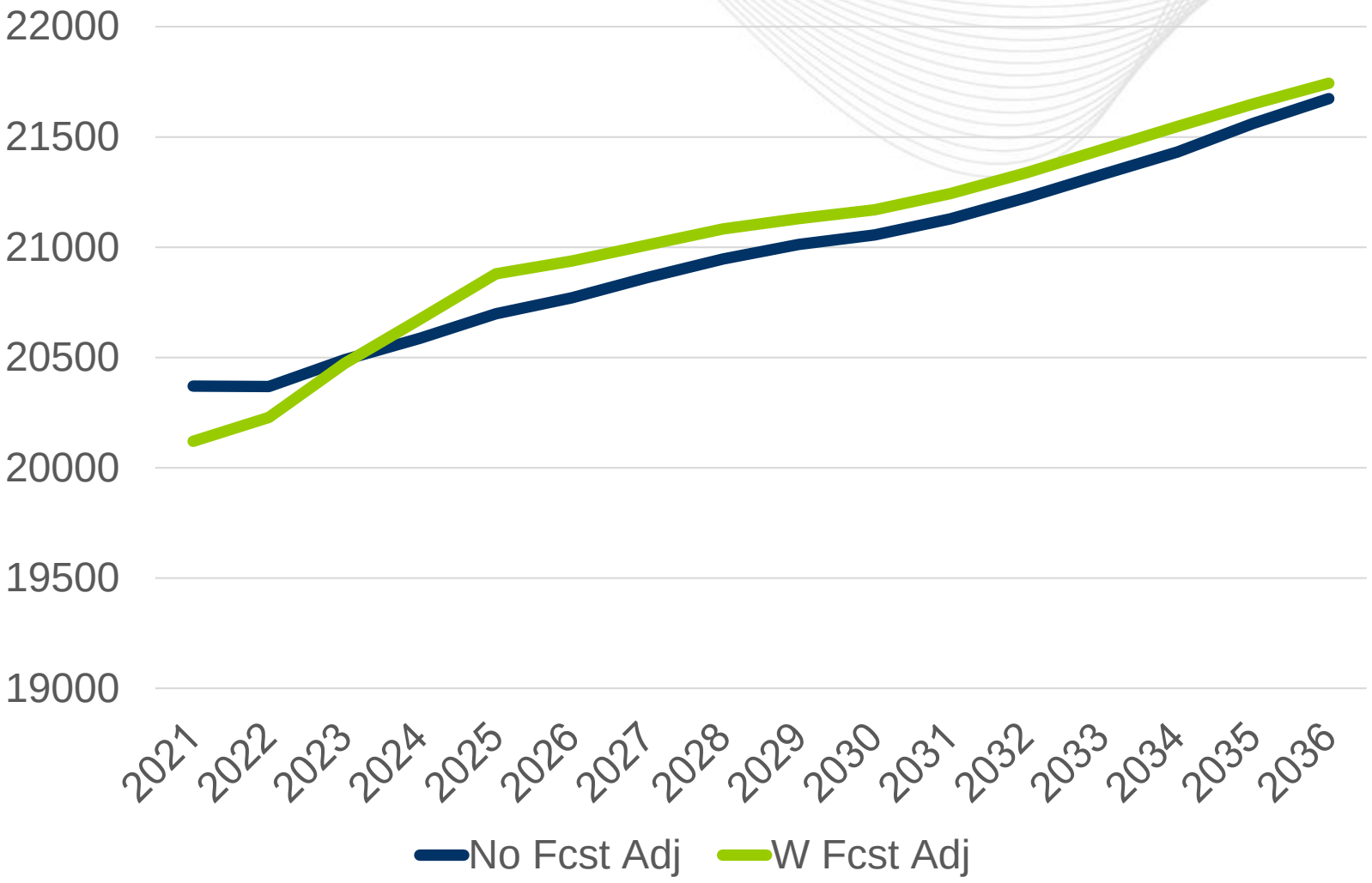
- Request related to Conservation Voltage Reduction program.
- Captured across all end-uses.
- Has an impact of minus 10 to 20 MWs.

COMED



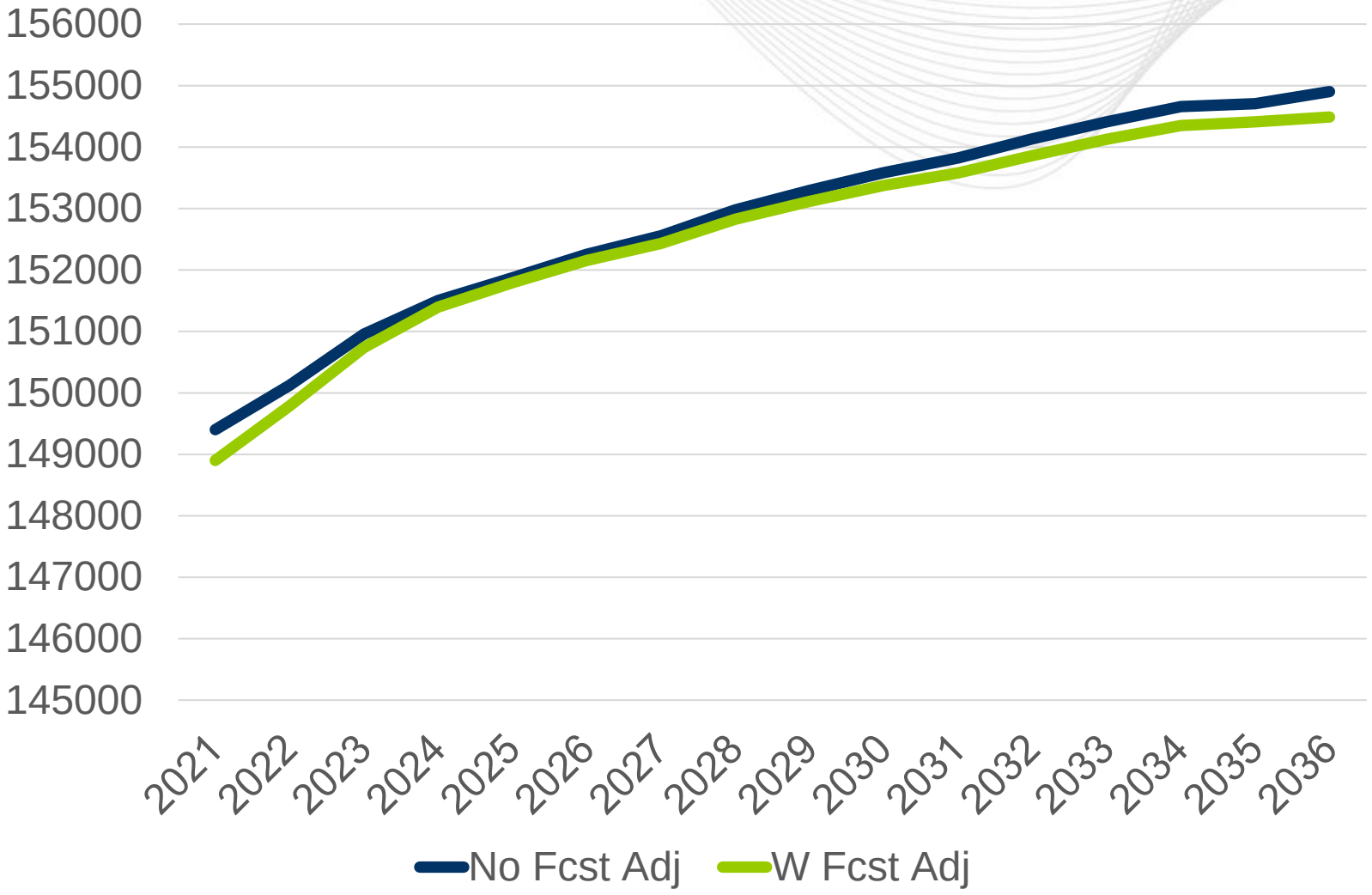
- Request related to Voltage Optimization program.
- Captured across all end-uses.
- Has an impact of minus 100 MWs at beginning of forecast and grows to minus to 220-230 MWs.

DomVP



- Request related to data centers.
- Captured in the Commercial sector (as Commercial Other).
- Has a negative impact of 250 MWs in the early part of forecast and grows to as much 180 MWs in 2025 before tapering.

RTO



- Cumulative impact of forecast adjustments subtracts 100-500 MWs over the forecast horizon.

Model Development Opportunities

- Investigate Commercial model, in particular look at Commercial Real Output as a potential driver.
- Investigate potential to add geographic or industry-specific information to industrial intensity measure.
- Investigate bringing model to hourly frequency. Needed to help better understand evolving trends such as behind-the-meter solar.

Next Steps

- Review with Planning Committee (12/1/2020)
- Publish final report in late December
  - Accompanying spreadsheets
    - Unrestricted Loads
    - Model Details Spreadsheets
    - End-Use Indices
    - Weather Variables
    - Statistical Appendix
  - Finalize Load Report Supplement

Contact

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Long-Term Load Forecast

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