

Improvement 3 – IRP Forecast Support

Addendum to April 2024 IRP Report – High Scenario Update

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1. Introduction

In February 2024, Guidehouse submitted an updated set of hourly forecast loads to LUMA for use in its IRP. The report¹ associated with those outputs was finalized in April 2024 (Guidehouse April 2024 report).

Guidehouse submitted three sets of hourly forecast loads to LUMA, a base, a high, and a low scenario. In October 2024, the LUMA IRP team requested that Guidehouse move rapidly to update the high IRP scenario.

On October 15, LUMA provided approval to Guidehouse to begin work to update the high scenario outputs to reflect:

- Updated forecast macro-economic inputs (including consideration of the updated forecast of and revision of historical Gross National Product (GNP) estimates provided by the FOMB to LUMA in March of 2024),
- Updated industrial regression model parameter estimates (aligned with those used for the FY24 Fiscal Plan),
- An updated set of cooling degree days (CDD), including those observed in the summer of calendar year 2024², and
- The higher levels of coincident peak demand observed during the summer heat waves of 2023 and 2024 (forecast peak demand by scenario is informed by the distribution of trend-normalized historical peaks).

The LUMA IRP team determined that, given the critical importance of obtaining a timely update to input into its downstream IRP processes and the fact that the changes in observed conditions most significantly impacted upper bound demand estimates, updates were essential for the high scenario only. The base scenario and low scenario have not been updated and remain as published in the IRP report cited above.

Guidehouse completed this work and delivered the updated high scenario outputs to the LUMA team on November 1.

This document is an addendum to the prior Guidehouse April 2024 report, and is intended to document **why** the high scenario update was requested by the LUMA IRP team, **how** the Guidehouse team updated the IRP inputs to deliver the high scenario update, and **what** the impact was of these updates on the high scenario projected peak demand and annual generation.

¹ Guidehouse, prepared for LUMA, *Improvement 3 – IRP Forecast Support: Development of hourly customer class demand profiles by transmission planning area, 2024 – 2050*, 2024-04-18.

² Unless otherwise explicitly noted, all year references should be understood to refer to calendar years (i.e., January through December), rather than LUMA's fiscal year (July through June).

1.1 Context

The summer (May through October) of 2024 is, so far, the hottest summer observed within the NOAA historical data³ used by the LUMA Load Forecasting and Research (LFR) team for supporting its Fiscal Plan development. Over this summer 2024 period, there were 3,836 cooling degree days (CDD), approximately 10% higher than the average summer CDD observed in the previous five years.

Effects of this extended period of high temperature included a substantial increase in residential and (to a lesser extent) commercial energy consumption beyond typical historical levels, and the highest coincident system peak demand served by generation since 2013.

In addition, in March 2024 (after the monthly sales forecast used as an input for the IRP disaggregation had been produced), the Financial Oversight and Management Board for Puerto Rico (FOMB) provided the LUMA LFR team with updated macroeconomic inputs (“macros”) for the Fiscal Year 2024 Fiscal Plan. These FOMB forecasts are also used as inputs in the IRP forecasting workflow.

The updates provided by the FOMB in March 2024 were a substantial revision over previously provided inputs for the first 10 years of the forecast period: updated GNP values were on average 2 – 3% higher than those provided for the Fiscal Year 2023 Fiscal Plan, and the annual population growth rates were on average approximately half a percentage point higher.

Given the potentially compounding effects of both changes on the high IRP forecast scenario, the LUMA IRP team believed that it would be prudent to engage Guidehouse to update the inputs for that scenario and re-run it.

Speed of update was determined to be critical, given that the unadjusted Guidehouse forecast results are inputs for down-stream IRP processes, and that the IRP filing date with the Energy Bureau had already been delayed multiple times. The Guidehouse and LUMA team understood that in the absence of a timing constraint it would have been preferable (for completeness and consistency) to update all three IRP scenario outputs. Considering the practical timing constraint, it was decided to update only the high scenario.⁴

1.2 Summary of Updates

In developing the updated high scenario IRP projection, Guidehouse has updated five inputs. The updates include:

1. **GNP Update.** Guidehouse updated the high scenario projected GNP series to reflect the updated economic projections of the FOMB and Moody’s. The GNP series is applied to the estimated regression parameters to drive the high scenario forecast of commercial and industrial sales.
2. **Population Update.** Guidehouse updated the high scenario projected population series to reflect the updated population growth rates projected by the FOMB. The population

³ These data extend back to 1992.

⁴ The Guidehouse team understands that analysis undertaken by the LUMA IRP and LFR teams identified that updates to the base scenario sales forecast (which uses the same models and inputs as the Fiscal Plan), and the impacts that these updates would have on the aggregate forecast of base scenario generation requirements, would not have meaningfully altered the IRP team’s downstream analysis.

series is applied to the estimated regression parameters to drive the high scenario forecast of residential sales.

3. **CDD Update.** Guidehouse updated the high scenario IRP analysis to include observed historical CDD through September of 2024. CDD impact the aggregate IRP generation forecast through their effects on the monthly residential and commercial sales forecast.
4. **Peak Volatility Factor Update.** Guidehouse updated the peak demand volatility factor to reflect the increased range of variation in de-trended system peak demand driven by the extreme weather observed in the summer of 2024. The volatility factor is applied to the hourly disaggregation of peak monthly sales to reflect the historically observed range of variation in in annual peak demand values due to factors beyond macroeconomic trends and monthly CDD.
5. **Industrial Model Update.** Guidehouse updated the industrial monthly regression model parameters used to forecast industrial sales to align with the regression model parameters used to forecast the FY2024 Fiscal Plan. This update was necessary due to the inclusion of the updated (higher) GNP projection. Without an update of the model parameters the industrial model would, when applied to the updated GNP, over-forecast sales in the high scenario.

1.3 Addendum Structure

The remainder of this report is divided into three sections.

1. **Input Updates.** This section provides a description of the updates applied to the inputs and the reason for each update.
2. **Updated Outputs.** This section provides a summary comparison of the updated high scenario forecasts with the unchanged base and low scenario, as well as with the prior scenario forecasts.

2. Input Updates

This section describes each modification applied in this update to the high demand scenario.

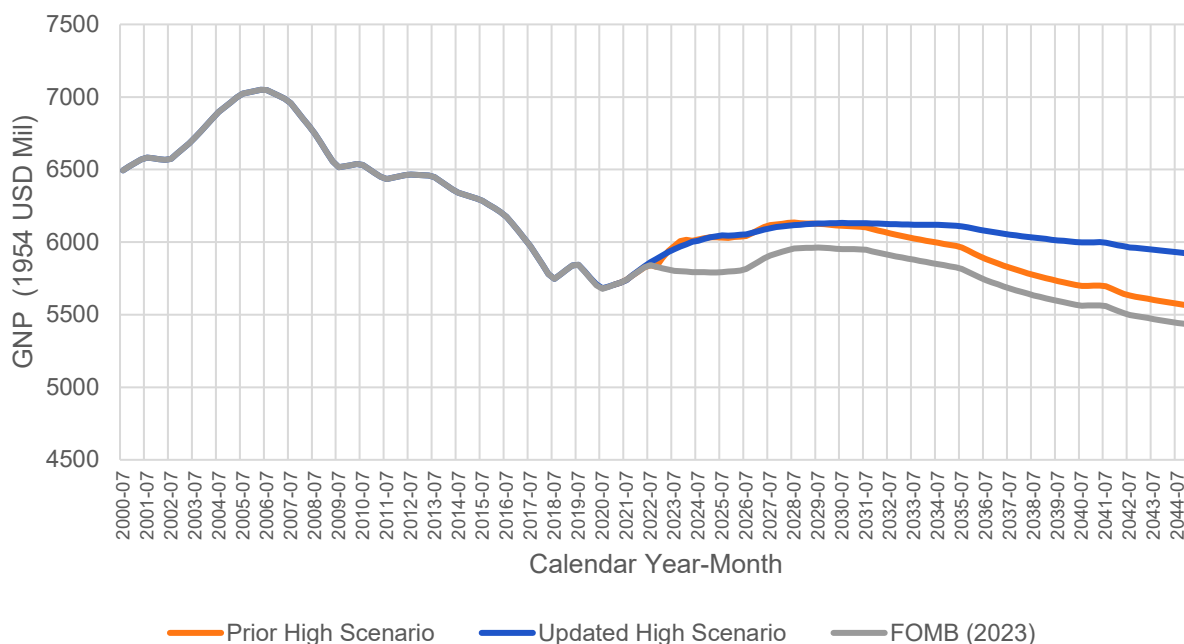
2.1 GNP Update

Guidehouse updated the high scenario projected GNP series to reflect the updated economic projections of the FOMB and Moody's Analytics. The GNP series is applied to the estimated regression parameters to drive the high scenario forecast of commercial and industrial sales. The updated GNP series used for the high scenario increases forecast monthly sales relative to the previous GNP series used, particularly after 2030.

Figure 1 displays the GNP⁵ projections used for:

- the base scenario ("FOMB (2023)")⁶ – dark grey line,
- the high scenario as documented in Section 6.1 of Guidehouse's April 2024 report – orange line,
- the new updated high scenario, the development of which is described below – blue line.

Figure 1. GNP Forecast Comparison



The updated high scenario GNP forecast is similar to the prior high scenario GNP forecast until approximately 2030. After 2030 they diverge. The prior high scenario GNP forecast declines from approximately \$6.1 billion (1954 USD) in 2030 to approximately \$5.6 billion by 2044. The

⁵ Recall that GNP as used in this work is the monthly 12-month trailing sum of GNP in millions of 1954 dollars.

⁶ This GNP series is also the series used for the Fiscal Plan forecast produced in March of 2023.

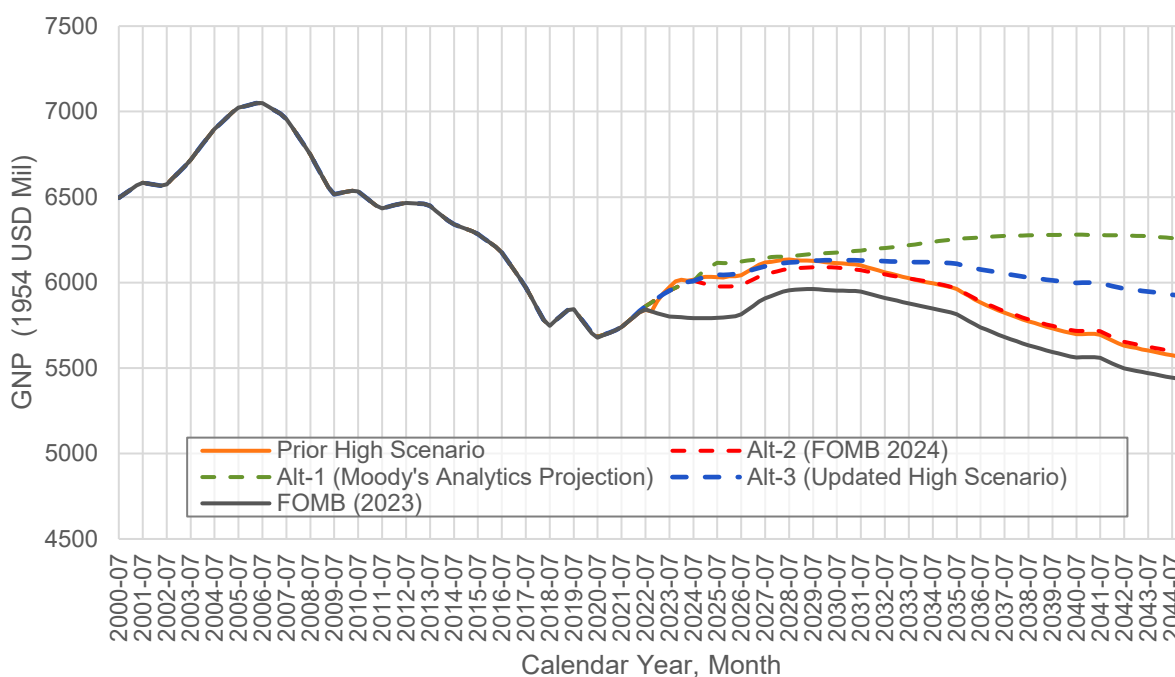
updated high scenario GNP forecast declines more gradually to approximately \$5.9 billion in 2044.

The three candidate alternative GNP forecasts that were considered are illustrated in Figure 2.

1. **Alternative 1** is a projection based on the Moody's Analytics high economic scenario GDP forecast.⁷ This alternative reflects the application of the Moody's Analytics GDP trajectory to historical GNP. It was calculated by applying the period-to-period percent change in the GDP forecast to the latest historical GNP value from FOMB. This is shown as the green dashed line in the figure below.
2. **Alternative 2** is the latest available GNP forecast from FOMB, received by Guidehouse in March of 2024.⁸ This is shown as the red dashed line.
3. **Alternative 3** is the mean of alternatives 1 and 2. This is shown as the blue dashed line.

This figure also includes the GNP forecast used in the high scenario forecast included in the Guidehouse April 2024 report, as a reference. This is shown as an orange solid line.

Figure 2. Candidate GNP Projections



The candidate alternatives are relatively similar in the near term (through 2030), but they differ meaningfully over the long run (through 2045).

By 2045, the Moody's-based projection (Alt-1) is 15% higher than the March 2023 FOMB forecast (grey line) used for the base scenario and 13% higher than the previous Moody's-based projection (orange line). The substantial change in the Moody's-based projection over a

⁷ Moody's Analytics Alternative Scenario 0 - Upside - 4th Percentile (October 2024)

⁸ This is the GNP forecast used for the LUMA Fiscal Plan produced in March of 2024.

relatively short period suggested to the Guidehouse team that projections based on the Moody's scenarios might be undesirably sensitive to Moody's modeling inputs, potentially as a result of the national (rather than regional) focus of Moody's modeling.

The Guidehouse April 2024 report noted that Moody's Analytics has communicated to the Guidehouse team that its macroeconomic scenario projections for Puerto Rico reflect high/low growth assumptions at the national level. The scenario dynamics of its Puerto Rico-specific projections are therefore driven by larger U.S. assumptions, an outcome that can sometimes result in apparently counterintuitive effects. The Guidehouse April 2024 report noted one such outcome was that the upside 4th percentile scenario resulted in GDP growth (reflecting national trends), but a reduction in population (driven by emigration to the continental U.S. in response to economic opportunity reflected by the higher GDP).

Based on the above, the LUMA IRP and LFR teams agreed that it would be prudent to consider alternative input GNP forecasts.

The principal available alternative GNP forecast for the high scenario was identified to be the updated FOMB forecast of GNP, shared with the LUMA LFR team in March of 2024 ("Alt-2 (FOMB 2024)"). This GNP forecast (that used in the Fiscal Plan forecast produced in March of 2024) is closely aligned with the prior high scenario GNP forecast. This alternative was regarded as unsuitably low.

One motivation for updating the high scenario had been the substantial upward revision by the FOMB of its GNP forecast, and it was agreed by the LUMA IRP team that it would be inappropriate not to increase the projected high scenario GNP scenario in response.

As a result, Guidehouse concluded that a compromise approach ("Alt-3 (Updated High Scenario)") averaging alternatives 1 and 2 would provide the most appropriate GNP forecast for the updated high demand scenario.

2.2 Population Update

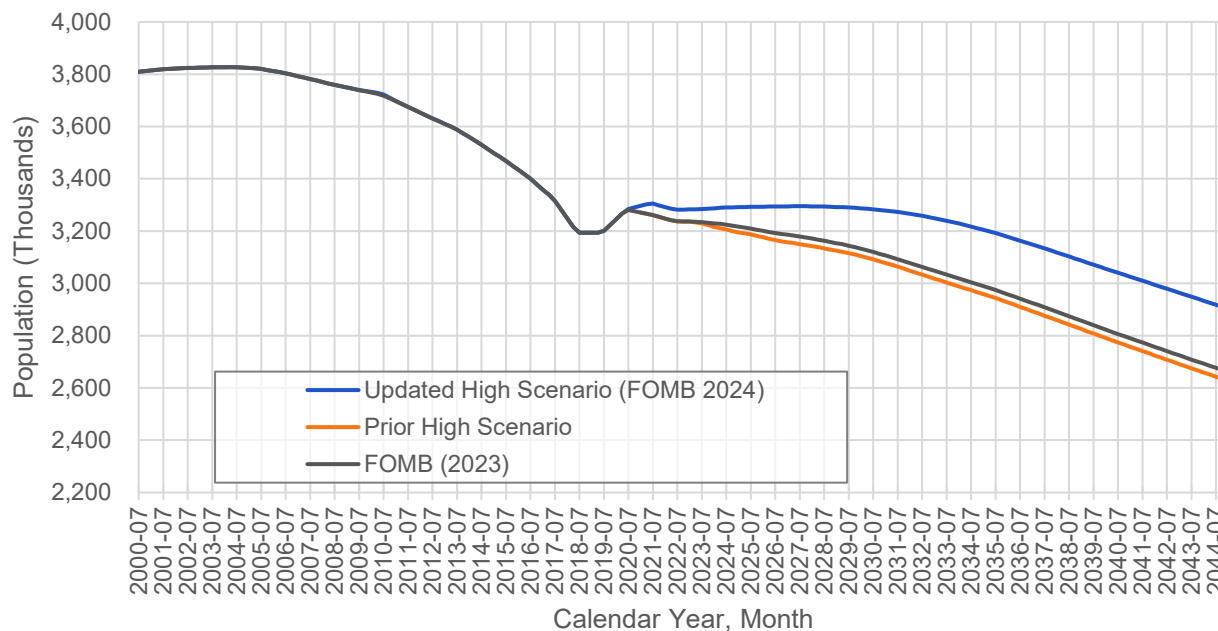
Guidehouse updated the high scenario projected population series to reflect the updated population growth rates projected by the FOMB. The population series is applied to the estimated regression parameters to drive the high scenario forecast of residential sales. The updated population series used for the high scenario increases forecast monthly sales relative to the previous population series included in the Guidehouse April 2024 report.

Figure 3 displays the population projections used for:

- the base scenario ("FOMB (2023)")⁹ – dark grey line,
- the high scenario as documented in Section 6.1 of Guidehouse's April 2024 report – orange line,
- the new updated high scenario, the development of which is described below – blue line.

⁹ This GNP series is also the series used for the Fiscal Plan forecast produced in March of 2023.

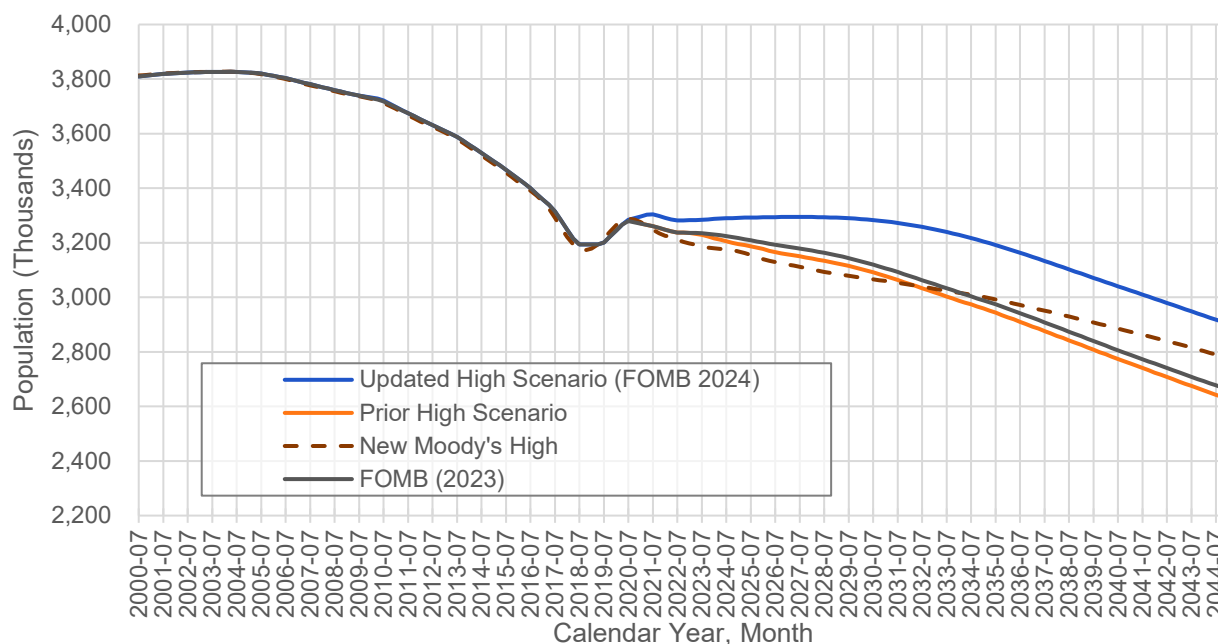
Figure 3. Population Forecast Comparison



As noted in Section 2.1, above, Moody's high scenario outputs¹⁰ project a counterintuitive divergence of GNP and population, with population projections in the high scenario that are lower than in the base scenario. This counter-intuitive effect remains in the most recently obtained Moody's outputs, shown as a dashed brown line below in Figure 4.

¹⁰ Moody's does not provide a forecast (or high scenario projection) of Puerto Rico GNP (in constant 1954 dollars). Moody's provides a GDP forecast, the growth rate of which Guidehouse applies to historical GNP values to extrapolate a GNP projection. Acknowledging that GNP and GDP capture different economic factors (most notably for Puerto Rico, GDP includes remittances whereas GNP does not), it was determined as part of the IRP development work that the historical correlation between the two series is sufficiently close that it is not unreasonable to derive a GNP forecast through the application of GDP year-over-year forecast growth rates to historical GNP.

Figure 4. FOMB and Moody's Analytics Population Forecasts



In fact, Moody's newest high scenario population projections are lower than those used previously by Guidehouse (the orange line) in the IRP outputs described in the Guidehouse April 2024 report. Following a review of these potential inputs to an updated IRP high scenario, the Guidehouse team recommended instead the use of the most recent FOMB-provided population forecast be used for the updated high scenario population projection.

This decision was motivated in part by the fact that the base scenario is not being updated, meaning that in this case the high scenario population forecast will be higher than that used for the base scenario. Should, at some future date, the IRP team determine that an update to the base scenario inputs is required, the Guidehouse team would recommend ensuring that, in any such subsequent updates, the high scenario population projection used should be higher than the base scenario population forecast.

2.3 CDD Update

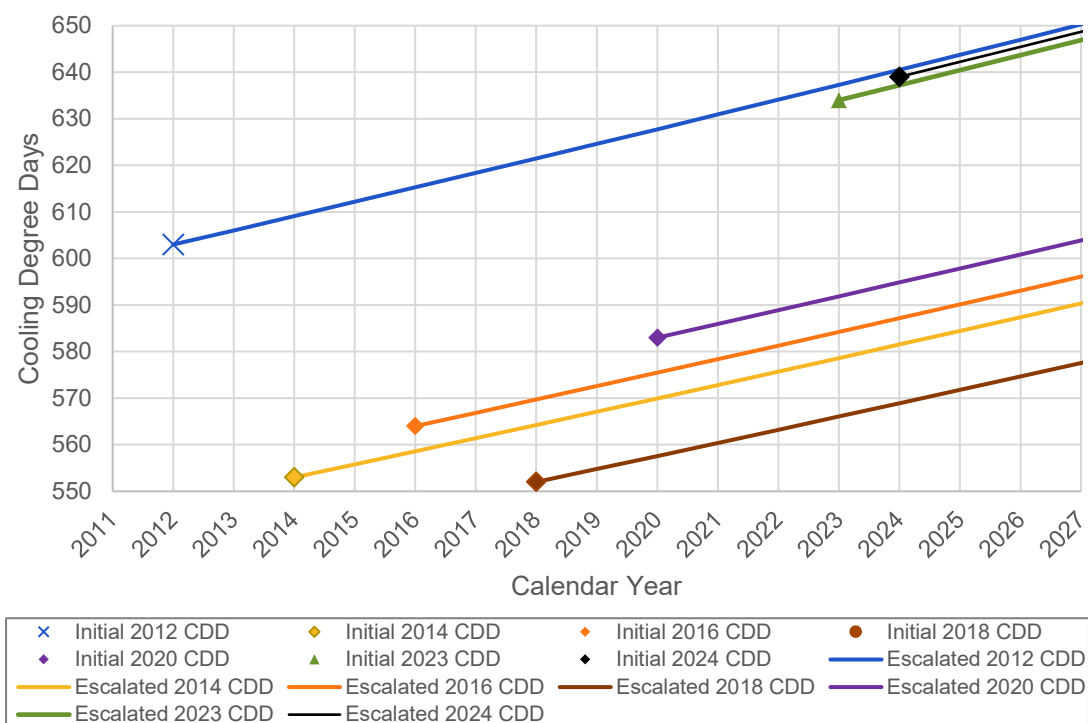
Guidehouse updated the high scenario IRP analysis to include observed historical CDD through September of 2024. CDD impact the aggregate IRP generation forecast through their effects on the monthly residential and commercial sales forecast. The CDD values affect these forecasts in two ways:

1. **Extreme Weather Distribution.** For the high scenario, forecast weather is selected as the annual set of monthly CDD values observed from July 2000 through September 2024 that, when applied to the forecast period, produce the highest system peak demand outcome. The historical CDD values are escalated at month-specific growth rates (see below).

2. **Month-Specific CDD Growth Rate.** As identified in Figure 7 of the Guidehouse April 2024 report, there is an unambiguous, approximately linear, upward trend in annual CDD. To account for this, the extreme weather used for forecasting the high scenario is escalated at the estimated historical growth rate (see Section 4.3 of the Guidehouse April 2024 report for more details).

Expanding the historical weather series to include the most recent monthly CDD resulted in no change to the historical CDD data selected as the extreme weather that drives the forecast peak demand. This result is due to the escalation applied to historical weather. This is illustrated in Figure 5, below. In this figure, a sample of observed historical September CDD are illustrated with markers (crosses, diamonds, triangles, etc.) The lines proceeding from these illustrate the escalated values in each year, reflecting the month-specific estimated growth rate. As may be seen here, although September 2012's CDD were significantly lower than September 2024 and September 2024's CDD, when escalated, the 2012 CDD are slightly greater than the escalated 2023 and 2024 values. As a result, the extreme value used for projecting the high scenario are based on escalations of observed 2012 CDD.

Figure 5. Example of Escalated Peak Month Historical Weather

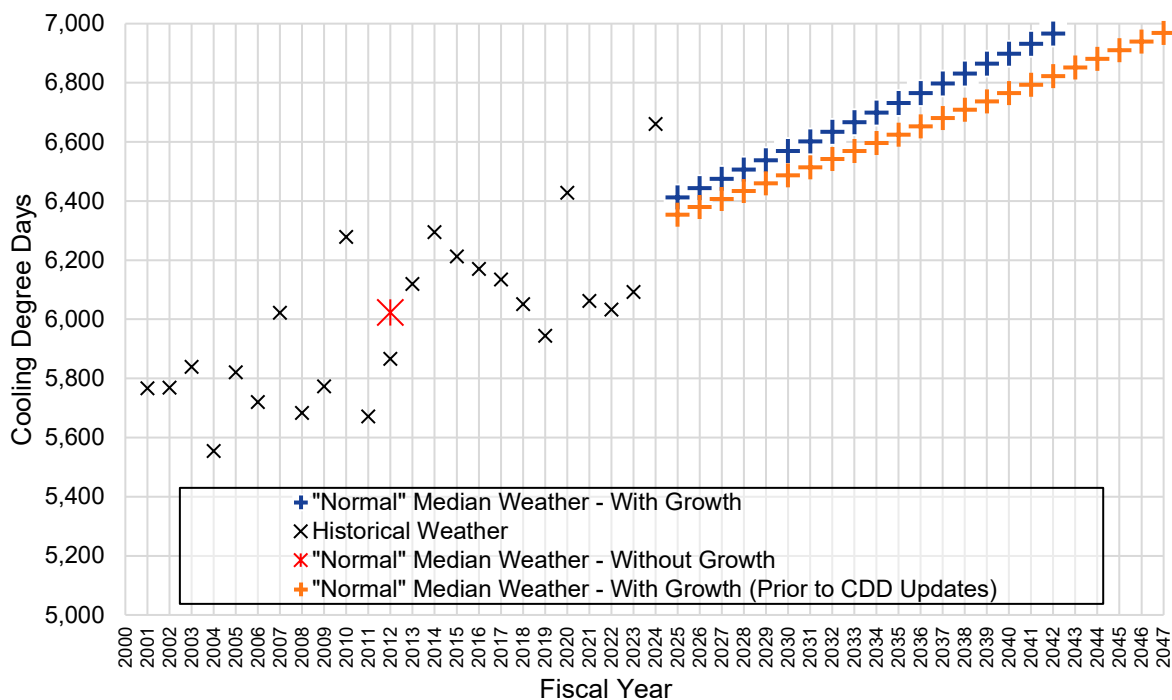


Although the updated CDD values do not impact the year from which the (escalated) extreme weather is drawn, the updated CDD values do materially steepen the overall trend in escalation. This is illustrated in Figure 6 below. This figure shows:

- Historical observed annual CDD (by *fiscal* year) – black crosses

- The median historical CDD (i.e., “normal” weather), without any adjustment to reflect the escalating trend – a red asterisk placed in 2012.¹¹
- The median *forecast* CDD (i.e., the forward-looking “normal” weather), based on the complete data set (i.e., including CDD through October of calendar year 2024) – blue crosses.
- The median forecast CDD *before the inclusion of the most recent historical values* – orange crosses.

Figure 6. Historical Annual CDD and Changing Trends



The inclusion of the most recently observed CDD has increased the slope of the trend used to escalate the extreme weather values applied to the residential and commercial regression parameters for projecting the high scenario. This means that the impact of the updated CDD will grow with time, and that all else equal, the updated high scenario should be expected: a) to be higher than the previous high scenario, and b) expand the gap between them over time.

Reviewers should recall that while the outputs of Guidehouse’s forecast scenarios are hourly, these are a disaggregation of a monthly forecast derived from the same inputs and methods as used for LUMA’s fiscal plan. This means that variation in weather impacts *monthly* consumption, which is then disaggregated to the hourly level. Because there does not exist sufficient class-level hourly data to drive the underlying temperature/peak demand relationship directly, the

¹¹ Although this value is placed in the median year – 2012 – the CDD noted here were not observed in that year. The median annual CDD is the sum of each month’s median value across the time-period considered (i.e., 2000 through 2024).

hourly weather-driven short-term volatility experienced most recently in Puerto Rico is captured by the “volatility factor”, described in Section 6.3 of the Guidehouse April 2024 report. The update to this value is discussed in the next section.

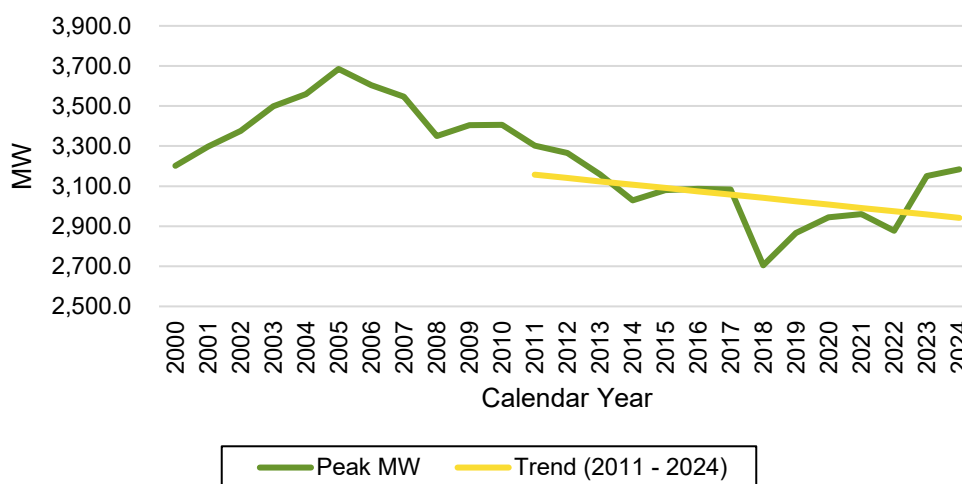
2.4 Peak Volatility Factor Update

Guidehouse updated the peak demand volatility factor to reflect the increased range of variation in de-trended system peak demand. The extreme weather observed in the summer of 2024 impacted the distribution of historical peaks (i.e., increase the range of variation) significantly, and therefore also increases the volatility factor. The volatility factor is applied to the hourly disaggregation of peak monthly sales to reflect the historically observed range of variation in annual peak demand values and to provide the projected peak demand values.

Guidehouse estimated and applied the peak volatility factor using the following steps.

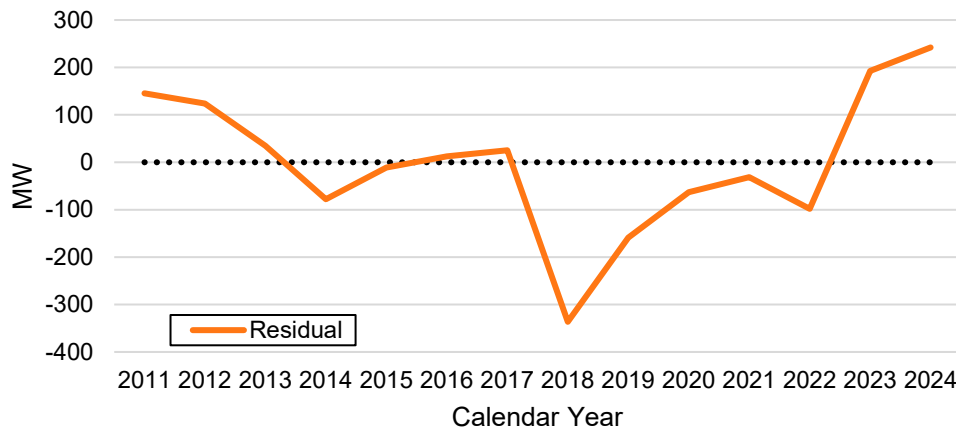
1. **Estimate Trend.** Guidehouse fitted a linear trend to historical observed generation peaks. Figure 7 depicts historical observed peak generation (green line) with a linear trend (yellow line) during the historical IRP study period (2011-2024).

Figure 7. Observed Historical Generation Peaks with Linear Trend



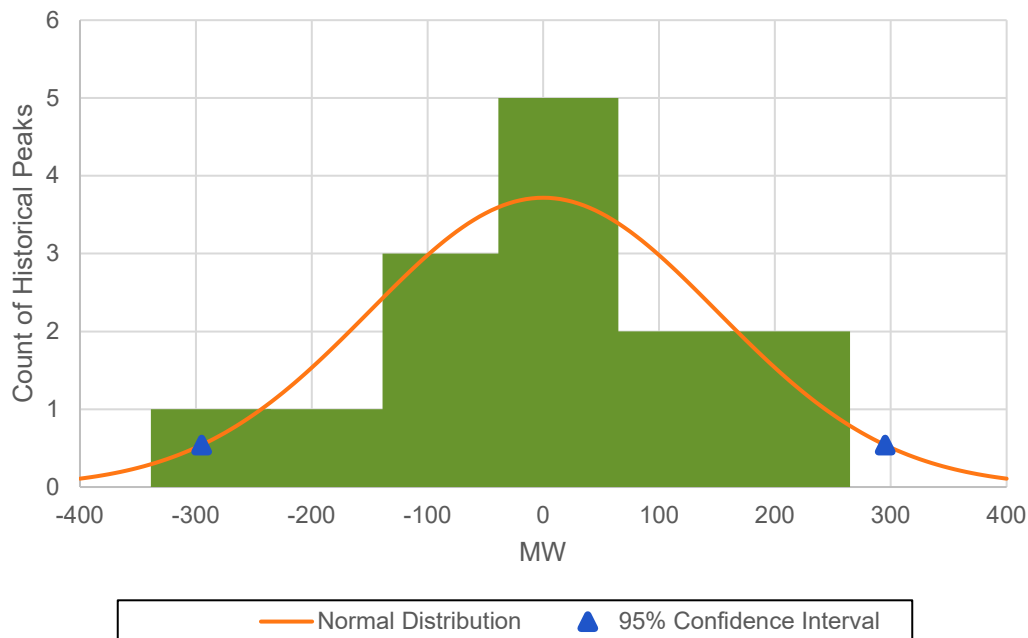
2. **De-Trend Peaks.** Peak demand, like annual sales, is driven by macro-economic trends. For the peak volatility factor, the Guidehouse team removes these trends from the data to avoid “double counting” them (macro-economic trends are embedded in the sales forecasts that are a function of population and GNP). To do so, the Guidehouse team estimates the trend (as described above) and calculates residuals, taking the difference between annual historical peaks and the linear trend estimated in step one. These residuals represent the deviation of historical peaks from the trend-normalized expected peak. Figure 8 depicts the annual residuals.

Figure 8. Trend-normalized Historical Peaks (Residuals)



3. **Estimate Distribution of Peaks and 95th Percentile Peak.** The Guidehouse team uses the trend-normalized peaks to estimate a 95% confidence interval, assuming the trend-normalized peaks follow a normal distribution. The upper confidence interval value provides a peak volatility factor that can be added to peak in the high demand scenario. Figure 9 depicts histogram distribution of the historical peak residuals with a normal distribution overlay calculated using the mean and standard deviation of the residuals. The blue triangle on the right side of the figure provides the upper limit of the 95% confidence interval value which lies at 295 MW.

Figure 9. Distribution of Peak Residuals



4. **Specify Class-Specific Peaks.** In each forecast year, identify class-specific coincident peak adjustment factors, equal to the product of the aggregate peak volatility factor (295

MW) and the class-specific peak demand contribution as a percent of total unadjusted peak demand.

5. **Adjust Class Peaks.** Adjust the demand for each class using the class-specific adjustment factor.
6. **Apply Proximate Hour Smoothing.** Using a 72-hour window centered on the peak hour, apply similar adjustments to the hours before and after the peak to maintain smooth demand profiles around the peak hour.

The inclusion of additional historical peaks from 2023 and 2024 resulted in an increase in the magnitude of the peak volatility factor. In the prior iteration of the high demand scenario, the peak adjustment factor was 170 MW. With the addition of the peaks in 2023 and 2024, the peak volatility factor increased to 295 MW.

2.5 Industrial Model Update

Guidehouse updated the industrial monthly regression model parameters used to forecast industrial sales to align with the regression model parameters used to forecast the FY2024 Fiscal Plan. This update was necessary due to the inclusion of the updated (higher) GNP projection. Without an update of the model parameters the industrial model would, when applied to the updated GNP, over-forecast sales in the high scenario.

Industrial sales are forecast using the same linear regression model used by the LUMA LFR team for projecting monthly sales as part of its Fiscal Plan forecasting (see Section 4.2 of the Guidehouse April 2024 report). In March of 2024, the industrial model used by the LFR team was re-estimated immediately prior to the production of the Fiscal Plan. Residential and commercial models were not re-estimated, and the estimated parameters for these models used for the FY2024 Fiscal Plan are the same as those used for the IRP outputs reported in Guidehouse's April 2024 report.

Re-estimation of the industrial model for the Fiscal Plan, following receipt of the updated FOMB macros, was essential to accommodate the updated macros provided by the FOMB. The updated macros provided by the FOMB included updates both to forecast and to historical GNP.¹² The values provided by the FOMB in March of 2024 were 2% higher for Fiscal Year 2023 (July 2022 through June 2023), and 4% higher for Fiscal Year 2024 (July 2023 through June of 2024).

The industrial regression model's forecast is particularly sensitive to changes in historical GNP due to the inclusion in that model of a binary variable to control for effects believed to be related to the recent and rapid growth of self-generation by many customers in this class. This binary variable captures the decline in industrial sales from the period beginning in March of calendar year 2022 through to the end of the estimation period, and its parameter estimate is particularly sensitive to the input GNP values in that same period.

¹² Historical GNP data typically remains subject to change for 2 – 4 years after that year has passed, due to lags in the updates of the various input variables tracked by the reporting agencies and used to estimate these macroeconomic values.

It was important to re-estimate the industrial model parameters for the high scenario following the revision of historical GNP inputs to avoid the industrial model over-predicting industrial sales when the forecast high scenario GNP is applied to the industrial model parameters. This can be demonstrated by reviewing the estimated model parameters in Table 1 below.

Table 1. Industrial Model Parameter Comparison

Variable Name	Previous Industrial Model Parameters (February 2024)	Current Industrial Model Parameters (February 2024)	Level Change
GNP (Millions, 1954 \$)	0.079	0.078	-0.00042
January Binary	-318	-316	2.5
February Binary	-310	-307	2.4
March Binary	-284	-281	3.0
April Binary	-299	-296	2.9
May Binary	-285	-282	2.8
June Binary	-286	-283	2.7
July Binary	-285	-282	2.5
August Binary	-273	-271	2.4
September Binary	-283	-281	2.0
October Binary	-280	-278	1.9
November Binary	-285	-283	2.7
December Binary	-289	-287	2.6
Industrial Binary	-24.4	-31.4	-6.9

The unadjusted industrial sales (in GWh) are forecast in each month by summing up the relevant monthly binary, the “industrial binary”, and the product of the GNP parameter and the forecast 12-month moving sum of the GNP. As may be seen, the sum of the relevant binary variables in each month (e.g., in January the sum of the January Binary and the industrial binary) is always larger in the older model than in the newer one. The GNP parameter is, likewise, lower in the new model. This means that, all else equal, the newer model (estimated using higher historical GNP values) will always predict a higher value of monthly industrial consumption (GWh).

Therefore, it is prudent to update the industrial parameters to ensure that industrial consumption is not overstated in the updated high scenario.

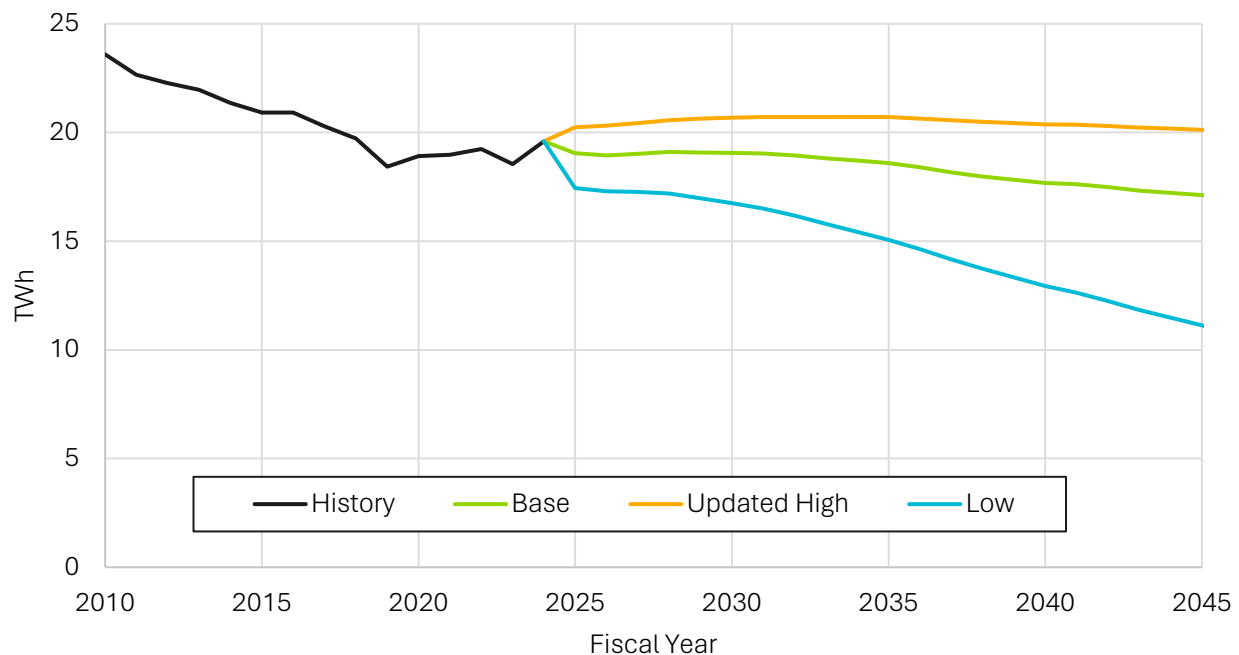
3. Updated Outputs

Guidehouse delivered the updated high scenario forecast, disaggregated by hour and TPA, as required by LUMA for its downstream IRP processes on November 1, 2024. This section provides aggregated summaries of these values to illustrate the differences between the new high scenario and the existing base and low scenarios, as well as between the new high scenario and the previous high scenario.

3.1 Aggregate Sales and Peak Demand Forecast

Figure 10 depicts annual generation history and the forecasts for the base, low, and updated high scenarios. The base and low scenarios are unchanged from the results in the full report.

Figure 10. Annual Generation History and Forecast Scenarios



The updated high demand scenario is 6% higher than the base scenario in 2025. The difference grows to 18% by 2045.

Forecast generation is estimated through the application of class-specific loss rates (estimated using historical loss analysis data collected by LUMA, as described in Section 5.4 of the Guidehouse April 2024 report). Total sales (i.e., energy consumption “at the meter”), historical, forecast, and for the high and low scenarios are provided in Figure 11, below.

Forecast generation is, for the purposes of the downstream IRP work, a much more relevant output metric than sales, these values are provided to allow readers to more easily compare the updated high scenario in this addendum with that in the Guidehouse April 2024 report. Figure

11, below is directly comparable to the sales values in Table 6 included in Appendix D of the Guidehouse April 2024 report.

Figure 11. Annual Sales History and Forecast Scenarios

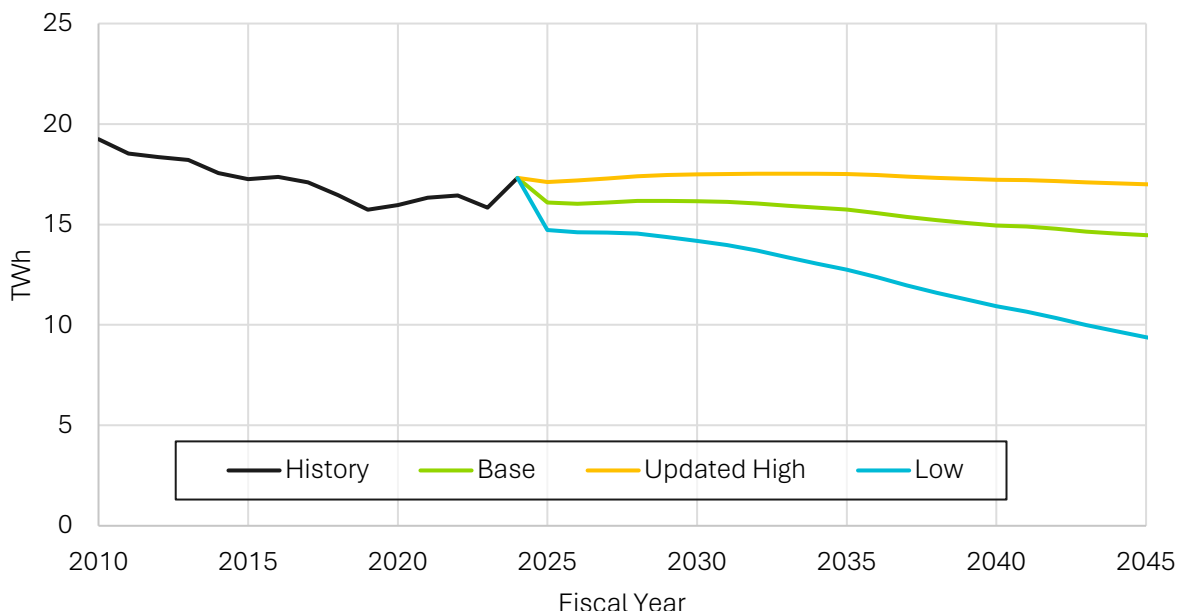


Figure 12 shows a comparison of the annual generation forecast between the prior and updated high demand scenarios. The generation forecasts are closely aligned in 2025, with the updated high scenario projecting generation that is only 1% higher than the previously used high scenario. The updated high scenario generation projection remains relatively flat through 2045 while the prior high demand scenario gradually declines. The difference between scenarios begins to grow materially in 2030 and by 2045, the current high scenario generation projection is 9% higher than that projected by the previous high scenario.

Figure 12. Annual Generation Forecast – High Demand Scenario Comparison

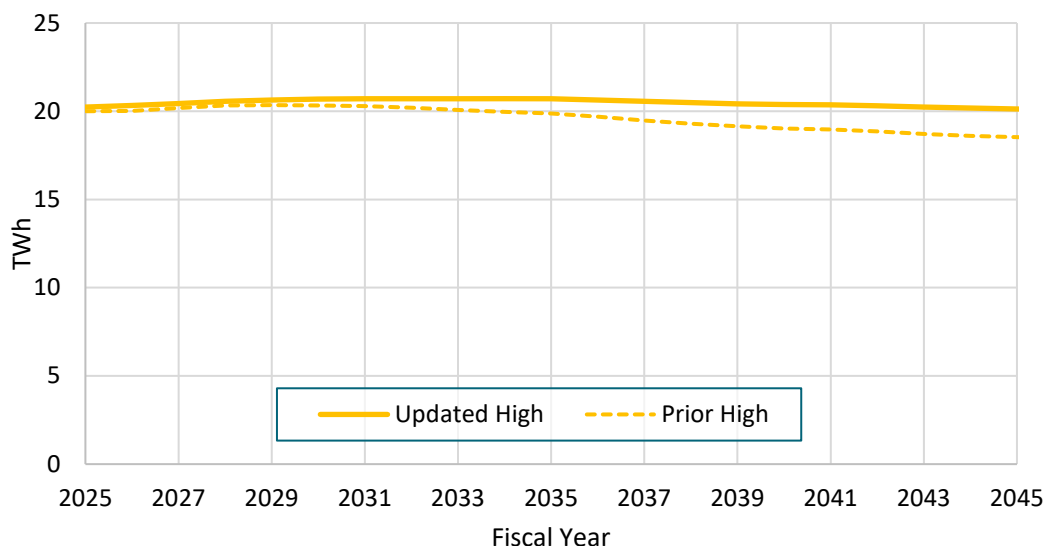


Figure 13 depicts the peak demand history and forecasts for the base, low, and updated high demand scenarios. Peak demand in the updated high scenario increases gradually to 2036, then remains relatively flat. The difference in peak demand between the base and high demand scenarios is driven primarily by two factors:

1. The peak volatility factor (see Section 2.4) is applied to the projected hourly disaggregation of sales in the peak month to account for additional short-term demand variation due to factors beyond macroeconomic conditions and monthly CDD.
2. The increase in residential sales relative to the base scenario, which, in turn, is driven by a higher population forecast, higher assumed monthly CDD values, and differences in the assumed persistence of the post-2019 step-change in residential summer consumption (see Section 6.4.2 of the Guidehouse April 2024 report).

Figure 13. Peak Generation History and Forecast Scenarios

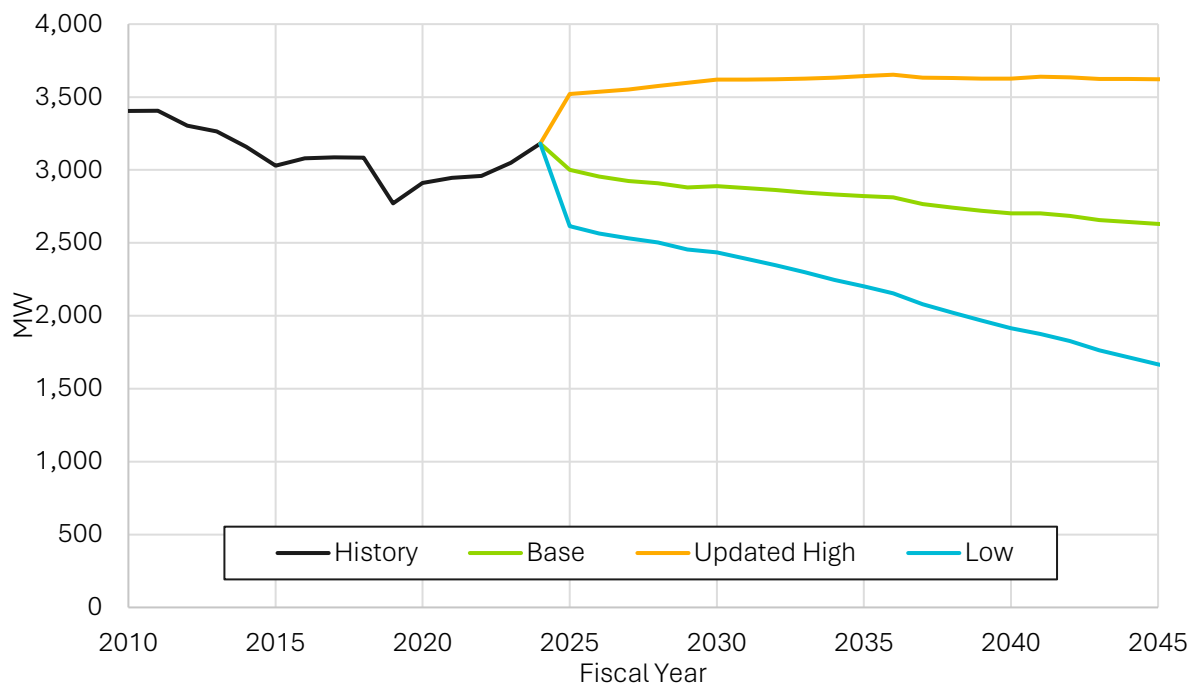
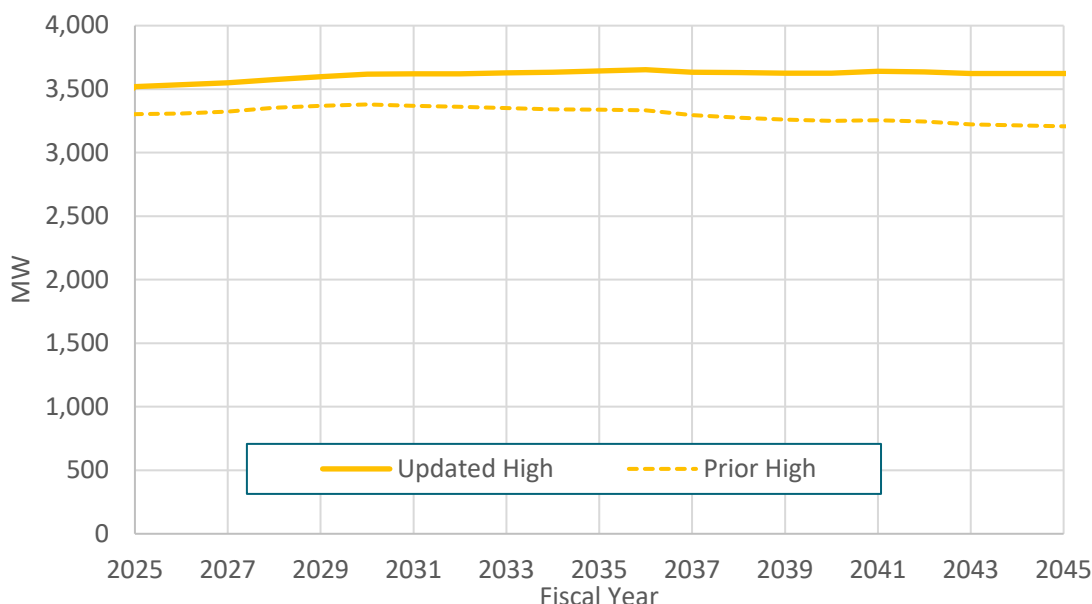


Figure 14. shows a comparison of peak demand forecasts between the updated and prior high demand scenarios. In 2025, peak demand is 7% higher in the updated high forecast compared to the prior high demand forecast. The difference grows to 13% by 2045.

The importance of the residential class of customers in driving the peak is evident from a comparison of this graphic with the descriptions of the updated inputs in Section 2. The GNP and CDD updates described in that section are demonstrated to be very similar to their prior values in the initial years of the forecast period. It is only past 2030, for example, that the updated GNP series materially deviates from the prior high scenario GNP. The population projection, in contrast, begins the forecast period materially higher in the updated high scenario than in the prior high scenario.

In addition, residential consumption has a larger impact on peak because historical and forecast peaks occur during evening hours when residential consumption is relatively high compared to other classes.

Figure 14. Annual Peak Forecast – High Demand Scenario Comparison



3.2 Sales Forecast by Class

The following section summarizes the updated energy forecasts for the primary customer classes (residential, commercial, and industrial). The results in this section represent energy at the generation level, as opposed to metered sales.

Figure 15 shows the residential energy forecast for the base scenario (green line), and the updated (solid orange) and prior (dashed orange) high demand scenarios. The primary driver of the change in residential energy between the updated and prior high demand scenarios is the updated population forecast, and the steeper month-specific trend in annual CDD growth. The impact of the population forecast change is evident as the step-change difference between the updated and prior residential high scenario projections, matching the step-change between updated and prior high scenario population projections shown in Figure 3.

Figure 15. Residential Generation Energy Forecast Scenarios

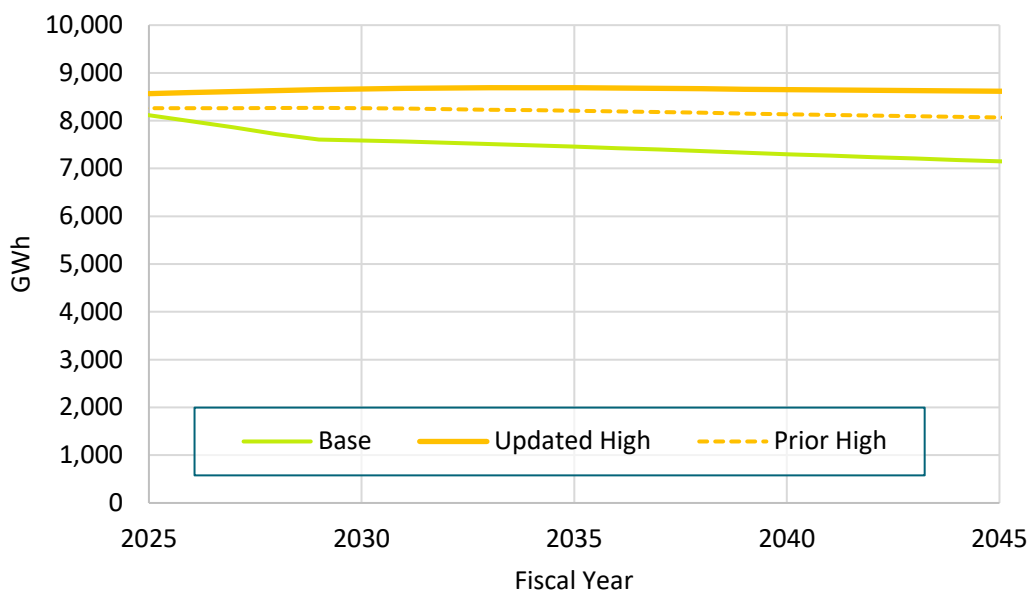


Figure 16 shows the commercial energy forecast for the base scenario (green line), and the updated (solid orange) and prior (dashed orange) high demand scenarios. The primary driver of the change in commercial energy between the updated and prior high demand scenarios is the updated GNP forecast. The impact of the GNP forecast change is evident as the way that the two (prior and current) high scenario energy forecasts are nearly the same until 2030, when they begin to deviate, matching the relationship between updated and prior high scenario GNP projections shown in Figure 1.

Figure 16. Commercial Generation Energy Forecast Scenarios

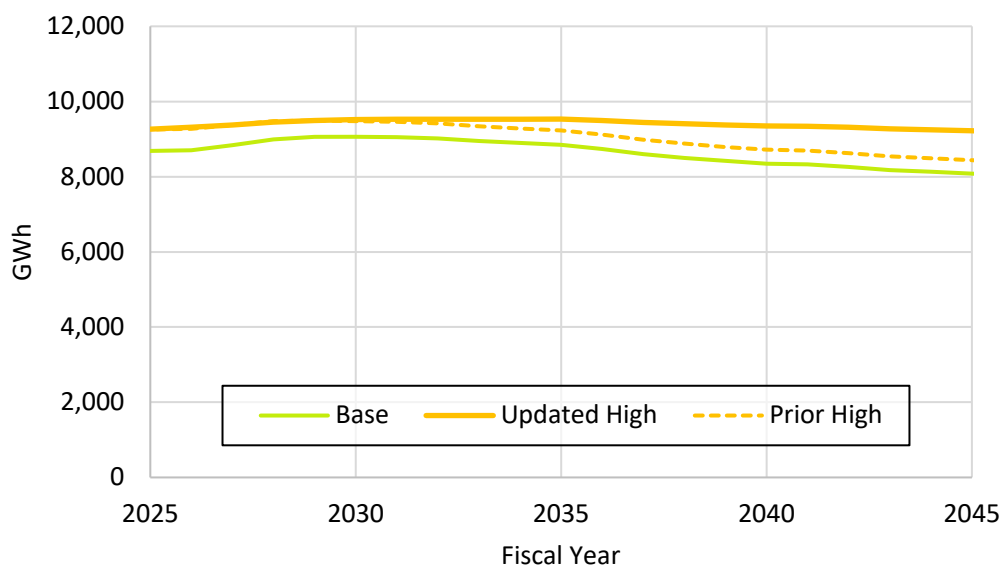


Figure 17 shows the industrial energy forecast for the base scenario (green line), and the updated (solid orange) and prior (dashed orange) high demand scenarios. The two primary drivers of the change in industrial energy between the updated and prior high demand scenarios are the updated GNP forecast and the updated industrial regression model parameters. The impact of the change in the industrial model regression parameters is evident in the first few years of the forecast in which the current and prior GNP high scenario forecasts are similar. In this initial period the updated high scenario projection of industrial consumption is *lower* than the prior projection. This is driven by the change in regression parameters which, as noted in Section 2.5, all else equal, deliver a lower predicted value. The impact of the GNP forecast change is evident in that, over time, the prior forecast begins a steady downward trend, consistent with the prior GNP high scenario projection, whereas the updated energy forecast scenario follows a much shallower downward slope, aligned with that of the updated GNP projection shown in Figure 1.

Figure 17. Industrial Generation Energy Forecast Scenarios

