2022 Forecasting Benchmark Survey

Itron, Inc.
10875 Rancho Bernardo Road
Suite 200
San Diego, CA 92127

October 27, 2022

2022 Forecasting Benchmark Survey

Since 2012, Itron's annual benchmarking survey has reported a broad picture of the electric and natural gas industry's forecasting practices. Like prior years, the 2022 survey examines forecast accuracy, growth projections, and forecast characteristics. This year, the forecast characteristics surveyed included COVID-19 impacts, electric vehicles, photovoltaics, storage, normal weather, and economic drivers.

The survey collects data from February through July and culminates with this report. This year, 88 companies responded to the survey representing over 2.3 billion MWh of electricity and almost 1.0 BCF of natural gas. Figure 1 shows the number of survey responses for 2022 and the prior years.

Figure 1: Survey Respondents

Year	Electric	Natural Gas	Total
2012	77	NA	77
2013	74	NA	74
2014	71	10	81
2015	75	9	84
2016	64	8	72
2017	73	13	86
2018	78	16	94
2019	61	12	73
2020	48	11	59
2021	85	10	98
2022	73	13	88

This report includes the following sections.

Forecast Accuracy Overview

Since 2012, Itron has asked companies to provide forecast accuracy statistics. Like last year, this year's results continue to be impacted by COVID-19.

When the first COVID-19 healthcare orders appeared in March 2020 (i.e., stay-at-home, and work-from-home orders), residential sales increased, and non-residential (commercial and industrial) sales decreased. These unanticipated changes created larger-than-normal errors in 2020.

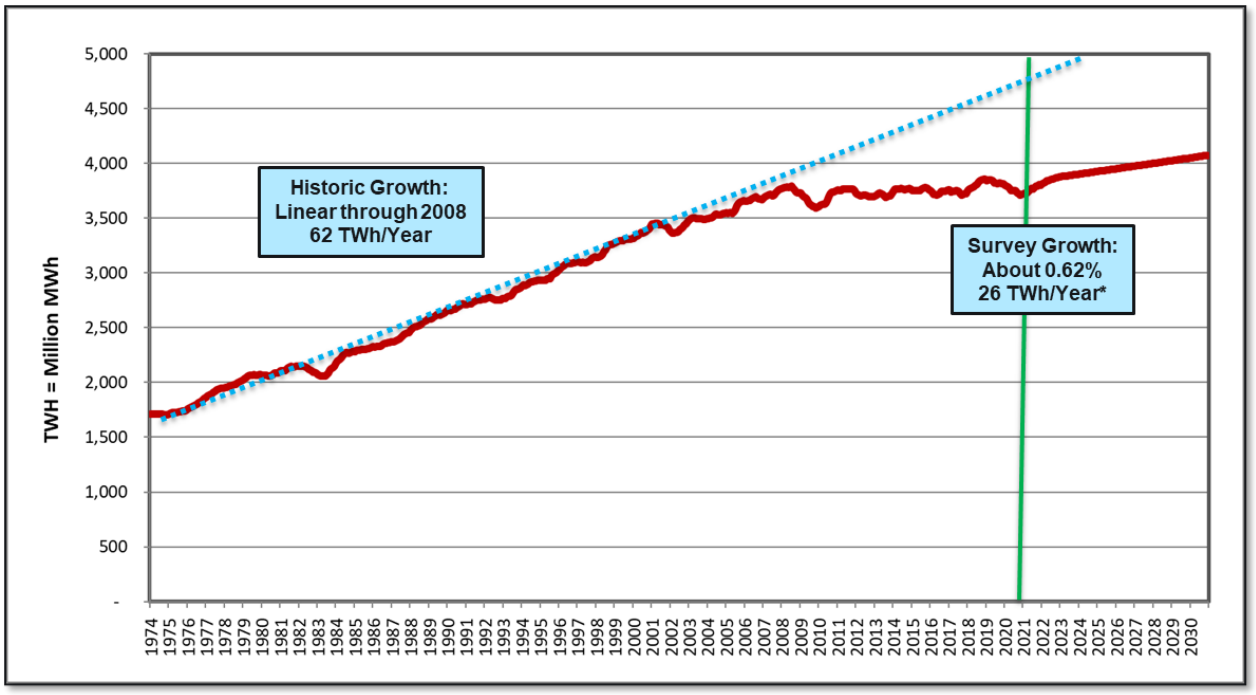
Forecasts for 2021, generated in 2020, struggled with predicting the changing COVID-19 healthcare policy orders, the sustainability of the COVID-19 2020 sales impacts, and the uncertain economy. This uncertainty resulted in higher than pre-pandemic average errors, but lower than 2020 errors. Accuracy statistics are shown in Figure 17 through Figure 20.

Electric Forecast Growth Overview

In 2020, COVID-19 increased residential sales while decreasing commercial and industrial sales. This result was largely due to the impact of healthcare orders. Despite the removal of many of these orders, 2021 sales have not returned to pre-pandemic levels. While residential growth has reverted to pre-pandemic growth rates, the overall level of residential sales remains high. Commercial and industrial sales have trended back to a normal level but have not achieved pre-pandemic levels. Figure 8 through Figure 12 show 2021 growth rates and the long-term forecast growth rates.

Figure 2 shows historical sales from 1974 through 2021 as 12-month rolling sums. The red line shows historic sales through 2021 with forecast sales based on the survey's retail projections through 2030. The blue dash line shows the long-term growth trend through 2008 and extrapolated from 2009 through the forecast period. This figure shows that 2021 sales remain low but are projected to return to pre-pandemic levels by 2023. The long-term forecast growth rate is 0.62% per year.

Figure 2: Survey Electric Sales Growth (TWH)



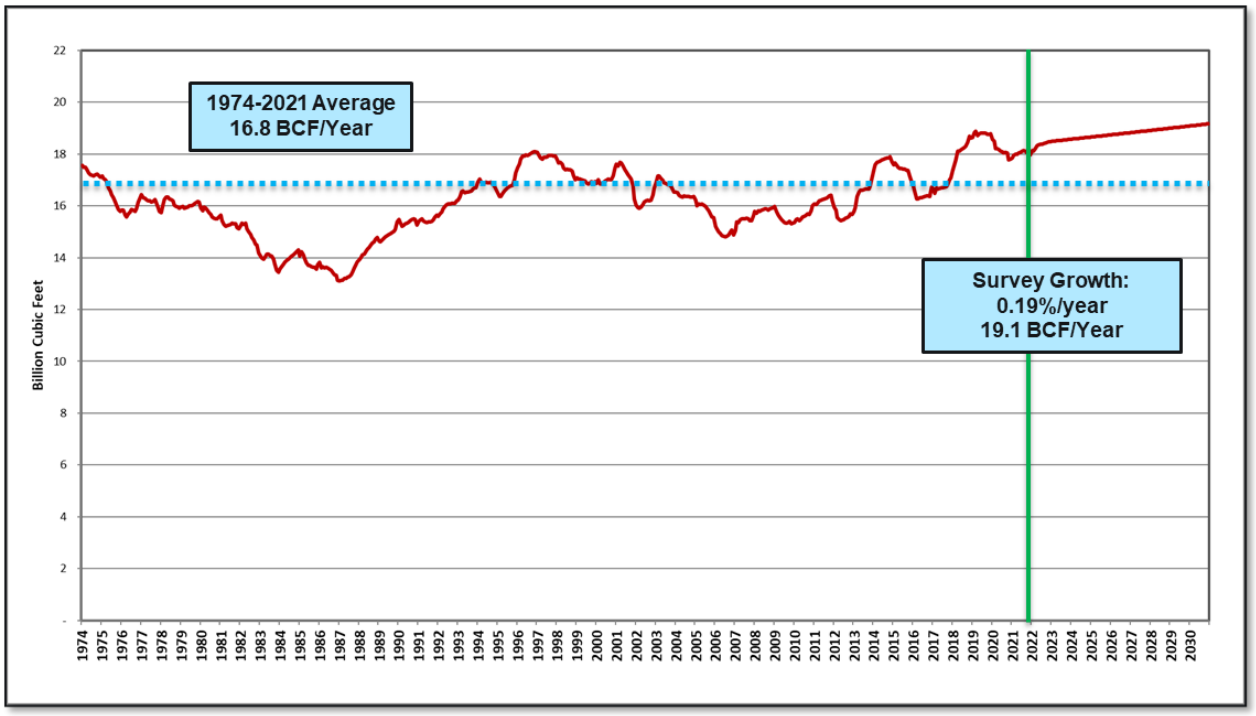
Natural Gas Forecast Growth Overview

COVID-19 impacted 2020 natural gas sales less than the electric industry. The reduced impact is due to two effects. First, COVID-19 healthcare orders began in March 2020 after the early (January through March) heating season. Second, many COVID-19 restrictions were removed by the late winter heating season (November and December).

The 2021 natural gas sales growth is slightly weaker than the pre-pandemic growth rate. While commercial sales have largely returned to pre-pandemic levels, residential and industrial sales continue to show weakness. Figure 8 through Figure 12 show 2021 growth rates and the long-term forecast growth rates.

Figure 3 shows a 12-month rolling sum of monthly retail gas sales. The forecast is based on reported forecast growth rates through 2030. This figure shows the impact of COVID-19 and the slow trend back to normal growth patterns.

Figure 3: U.S. Historical Natural Gas Sales (BCF)

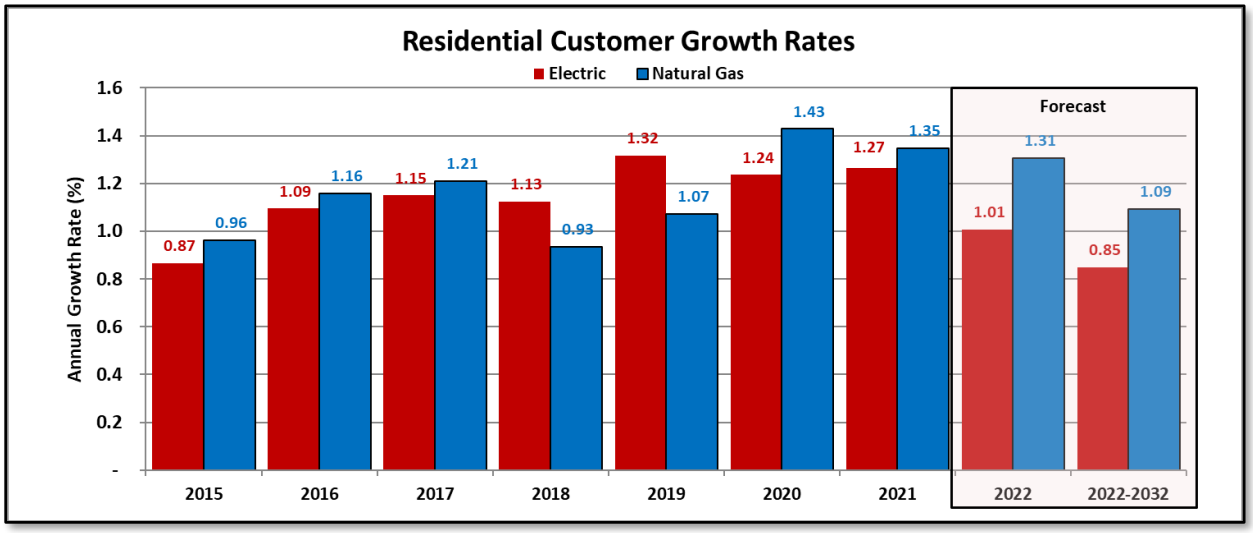


Customer Growth

Historical and forecast customer growth rates for the residential and commercial classes are shown in Figure 4 through Figure 7. Forecast growth rates for 2022 and the long term (2022-2032) are highlighted. Forecasts include respondents' expectations of COVID-19 impact and recovery. For comparative purposes, growth rates from the 2015 through 2019 (pre-COVID-19 growth) surveys are displayed with the 2022 survey results.

Residential Customer Growth. Figure 4 shows residential customer growth rates for electric and natural gas respondents. In 2021, electric customers grew by 1.27% and natural gas customers grew by 1.35%.

Figure 4: Residential Average Customer Growth (%)



The 2021 electric customer growth is slightly higher than the pre-COVID-19 growth rates and does not appear to be negatively impacted by the pandemic. Beginning in 2019, annual growth rates exceed 1.24% and are higher than pre-2019 growth rates (1.11%). Despite this 3-year increase, the forecast growth is lower than the pre-pandemic average growth rate which suggests that the 3-year increase is temporary.

Natural gas growth in 2021 (1.35%) continues to be strong relative to the pre-pandemic average growth (1.07%). However, the long-term forecast growth (1.09%) is close to the pre-pandemic 5-year average growth rate which suggests that the strong growth is temporary.

Figure 5 shows the regional growth rates. The figure shows the continued pattern of stronger residential customer growth in the South and West relative to the Northeast and Midwest regions, and consistent Canadian growth.

Figure 5: Residential Average Customer Growth by Region (%)

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Actual 2021	Forecast 2022	Forecast 2022-2032	Average 2015-2019
Canada	0.81	1.21	1.04	0.94	0.96	1.12	1.16	1.01	0.79	0.99
Midwest	0.55	0.82	0.77	0.61	0.72	0.92	0.71	0.51	0.44	0.69
Northeast	0.27	0.40	0.57	0.72	0.61	0.29	0.49	0.40	0.21	0.51
South	1.30	1.21	1.35	1.43	1.67	1.61	1.53	1.15	1.00	1.39
West	1.05	1.43	1.49	1.32	1.45	1.54	1.71	1.56	1.32	1.35
Total Electric	0.87	1.09	1.15	1.13	1.32	1.24	1.27	1.01	0.85	1.11
Natural Gas	0.96	1.16	1.21	0.93	1.07	1.43	1.35	1.31	1.09	1.07

Commercial Customer Growth. Figure 6 shows commercial customer growth rates for electric and natural gas respondents. In 2021, electric customers grew by 1.37% and natural gas customers grew by 0.57%. The electric growth is very strong and shows a "rebound" from the low 2020 growth. The rebound is caused by shutting down and then reopening of the economy. Natural gas growth is not impacted by the pandemic with 2021 growth consistent with the pre-pandemic average growth.

The electric customer forecast growth rates for 2021 and the next 10 years are 0.81% and 0.62% respectively. The electric forecast growth rates are slightly lower, but consistent, with the pre-pandemic growth rate. Like the electric growth forecast, the natural gas forecast is consistent with pre-pandemic growth.

Figure 6: Commercial Average Customer Growth (%)

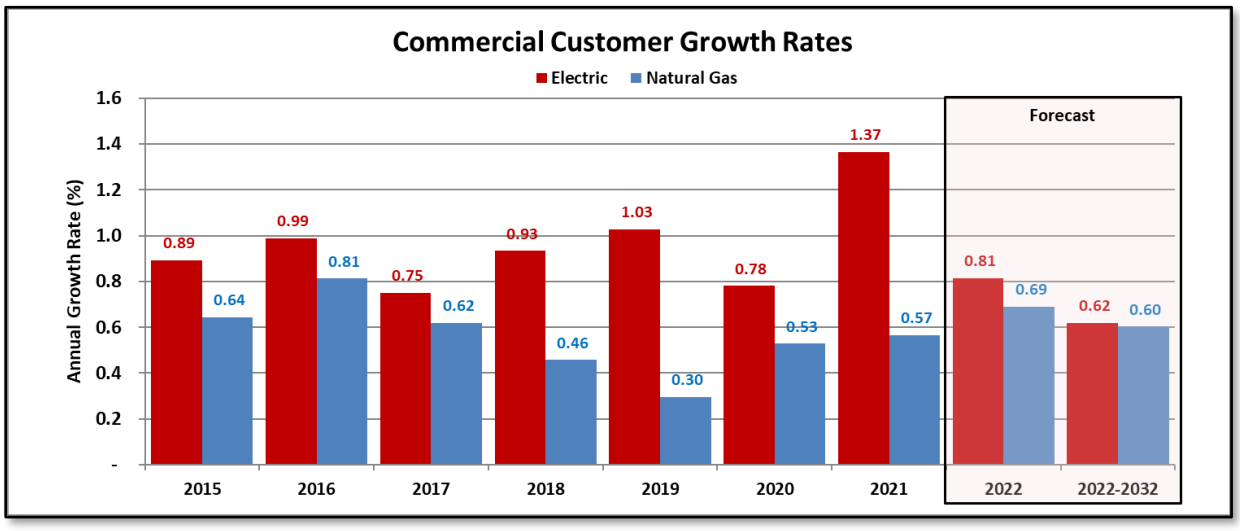


Figure 7 shows the regional growth rates. The figure shows the continued pattern of stronger commercial customer growth in the South and West relative to the Northeast and Midwest regions, and consistent growth in Canada.

Figure 7: Commercial Average Customer Growth by Region (%)

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Actual 2021	Forecast 2022	Forecast 2022-2032	Average 2015-2019
Canada	0.68	0.94	0.25	0.45	0.47	0.55	0.80	0.50	0.31	0.56
Midwest	0.83	1.08	0.71	0.66	0.72	0.46	0.77	0.49	0.37	0.80
Northeast	0.51	1.10	0.53	0.50	0.54	0.14	0.77	0.76	0.28	0.64
South	1.19	0.91	1.17	1.24	1.35	1.16	1.90	1.11	0.85	1.17
West	1.02	1.27	0.16	0.91	0.89	1.06	1.43	0.76	0.84	0.85
Total Electric	0.89	0.99	0.75	0.93	1.03	0.78	1.37	0.81	0.62	0.92
Natural Gas	0.64	0.81	0.62	0.46	0.30	0.53	0.57	0.69	0.60	0.57

Residential Sales Growth

Figure 8 shows past and current reported weather normalized residential sales growth rates. The figure also shows the 2022 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average (2015-2019) growth rate. Forecasts include respondents' expectations of the COVID-19 impact and recovery.

Figure 8: Residential Sales Growth

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Actual 2021	Forecast 2022	Forecast 2022-2032	Average 2015-2019
Canada	(0.97)	1.12	0.79	1.37	1.02	2.90	0.82	0.80	0.68	0.66
Midwest	(1.24)	(0.15)	(0.45)	0.09	0.19	3.71	(0.82)	(1.07)	0.28	(0.31)
Northeast	(1.25)	0.09	0.27	1.27	(0.57)	4.54	(0.85)	(1.97)	0.28	(0.04)
South	1.27	0.12	0.07	1.85	(0.22)	4.12	(0.09)	0.21	0.67	0.62
West	(1.11)	1.29	0.80	0.18	(0.10)	4.09	1.61	(0.82)	1.37	0.21
Electric Total	(0.38)	0.33	0.16	1.19	0.03	3.80	0.11	(0.07)	0.64	0.27
Itron WN	0.31	0.17	0.74	0.62	(0.42)	4.78	(0.13)			0.28
Natural Gas Total	(0.72)	0.91	1.53	(1.88)	1.08	1.15	(0.80)	0.71	0.55	0.19

Electric. Weather-normalized residential sales grew 0.11% in 2021. While 2021 growth is like the pre-pandemic growth, it does capture any "rebound" from the high 2020 growth. In other words, the 2021 increase shows that residential sales have not reverted to pre-pandemic levels. Instead, residential sales continue to be high and have resumed its long-term growth pattern at this new high level.

The 2022 forecast growth is -0.07%. The negative growth predicts movement back toward the pre-pandemic level but is too small to reverse the 3.80% growth in 2020. The long-term forecast growth is 0.64%, higher than the pre-pandemic average growth, and shows that companies do not expect the residential class sales to revert back to pre-pandemic levels.

Regionally, the West and Canada show strong growth relative to pre-pandemic growth and do not show any signs of reverting to pre-pandemic levels. The Midwest, Northeast, and South show declining growth with sales beginning to revert back toward pre-pandemic levels.

Natural Gas. Weather-normalized residential natural gas sales decreased by 0.80% in 2021. The decline is unexpected and may reflect the small sample of natural gas companies. Despite the 2021 decline, the 2022 forecast (0.71%) and the long-term forecast (0.55%) are higher than pre-pandemic average growth suggesting that natural gas sales will recover and the 2021 decline is temporary.

Commercial Sales Growth

Figure 9 shows past and current reported weather-normalized commercial sales growth rates. The figure also shows the 2022 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average growth rate. Forecasts include respondents' expectations of the COVID-19 impact and recovery.

Figure 9: Commercial Sales Growth

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Actual 2021	Forecast 2022	Forecast 2022-2032	Average 2015-2019
Canada	0.51	1.14	0.51	1.86	0.81	(4.00)	0.68	2.57	0.65	0.97
Midwest	(0.48)	0.03	0.13	0.06	(1.22)	(4.91)	3.55	2.67	(0.05)	(0.30)
Northeast	(0.58)	(0.47)	(0.47)	(0.07)	(0.82)	(7.35)	1.41	2.29	(1.54)	(0.48)
South	1.07	0.24	0.24	1.88	(0.47)	(5.09)	2.82	2.24	0.52	0.59
West	0.43	0.24	0.24	0.55	(0.24)	(4.70)	4.09	2.85	2.50	0.24
Electric Total	0.28	0.32	0.32	1.25	(0.42)	(4.95)	2.51	2.46	0.53	0.35
Itron WN	0.04	(0.07)	(0.01)	1.34	(1.03)	(4.92)	2.90			0.05
Natural Gas Total	(0.58)	0.69	3.99	(1.04)	2.13	(2.97)	2.52	0.21	0.78	1.04

Electric. Weather normalized commercial sales increased 2.51% in 2021. The 2021 growth rate is much larger than the pre-pandemic growth rate and captures a "rebound" from the 2020 sales decline. Despite the strong 2021 growth, commercial sales have not recovered from the 2020 decline. However, when combining the 2021 actual growth and 2022 forecast growth, respondents are expecting commercial sales to return to pre-pandemic levels. After 2022, the long-term forecast is consistent with the pre-pandemic growth rates.

Regionally, the West shows strong growth and has almost recovered from the pandemic's impact. The Midwest, Northeast, South, and Canada show recovering sales slowly reverting to pre-pandemic levels.

Natural Gas. Weather-normalized commercial natural gas sales increased by 2.52% in 2021. Like the electric sales growth, 2021 natural gas growth rebounds from the 2020 sales decline. However, unlike the electric industry, natural gas sales have generally reverted to their pre-pandemic levels.

Industrial Sales Growth

Figure 10 shows past and current reported weather-normalized industrial sales growth rates. The figure also shows the 2022 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average growth rate. Forecasts include respondents' expectations of the COVID-19 impact and recovery.

Figure 10: Industrial Sales Growth

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Actual 2021	Forecast 2022	Forecast 2022-2032	Average 2015-2019
Canada	(1.57)	(1.41)	(1.06)	(1.59)	(0.27)	(0.93)	2.53	(0.69)	0.45	(1.18)
Midwest	(0.71)	0.41	0.20	1.29	(2.59)	(5.12)	4.30	3.53	0.36	(0.28)
Northeast	(3.44)	(1.74)	1.33	(1.15)	(2.63)	(5.96)	1.89	2.27	(0.17)	(1.53)
South	1.75	0.36	1.26	1.95	1.56	1.13	3.99	2.19	0.83	1.38
West	(1.47)	(1.89)	(1.97)	0.11	2.06	1.04	0.99	3.14	0.99	(0.63)
Electric Total	(0.33)	(0.23)	0.33	0.76	0.21	(1.09)	3.42	1.79	0.61	0.15
Natural Gas Total	(0.13)	4.61	2.33	(0.33)	3.23	(6.94)	(1.07)	4.75	0.33	1.94

Electric. Weather-normalized electric industrial sales increased by 3.42% in 2021. The increase more than offsets the 2020 decline. The increase is attributed to pandemic recovery including surging manufacturing output beginning in the third quarter of 2020 and strong growth in 2021. Of the 73

electric company responses, 33 companies report industrial growth of over 4%. The strong growth tends to be in the South and Midwest regions.

While growth is expected to be strong in 2022 (1.79%) and continue above the pre-pandemic growth rates for the ten-year forecast period, these projections were created in 2021 and probably do not include the current impact of high inflation and tightening interest rates.

Natural Gas. Natural gas companies saw average weather normal sales decrease by 1.07% in 2021. Natural gas companies expect sales to revert to pre-pandemic levels beginning in 2022, but long-term sales are expected to remain below the pre-pandemic growth.

System Sales Growth

Total system growth includes all utility classes and may include wholesale, resale, and agricultural classes. Figure 11 shows system growth with the 2022 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average growth rate. Forecasts include respondents' expectations of the COVID-19 impact and recovery.

Figure 11: System Energy

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Actual 2021	Forecast 2022	Forecast 2022-2032	Average 2015-2019
Canada	(1.41)	(0.02)	0.21	0.26	(0.08)	(0.31)	1.64	0.96	0.75	(0.21)
Midwest	(0.34)	0.35	(0.14)	0.14	(1.22)	(2.56)	2.02	1.29	0.18	(0.24)
Northeast	(1.59)	(0.41)	0.36	0.21	(1.22)	(3.55)	0.57	0.89	0.19	(0.53)
South	1.54	0.35	0.42	2.56	0.11	(0.26)	2.26	1.63	0.64	0.99
West	(1.18)	0.07	0.34	0.15	0.24	(0.31)	2.39	1.58	1.85	(0.08)
Electric Total	(0.12)	0.21	0.26	1.24	(0.25)	(1.14)	2.02	1.38	0.64	0.27
Itron WN	(0.17)	(0.22)	0.48	1.07	(0.51)	(1.10)	1.68			0.13
Natural Gas Total	1.50	1.48	1.54	(0.56)	2.82	(1.79)	0.59	1.96	0.73	1.36

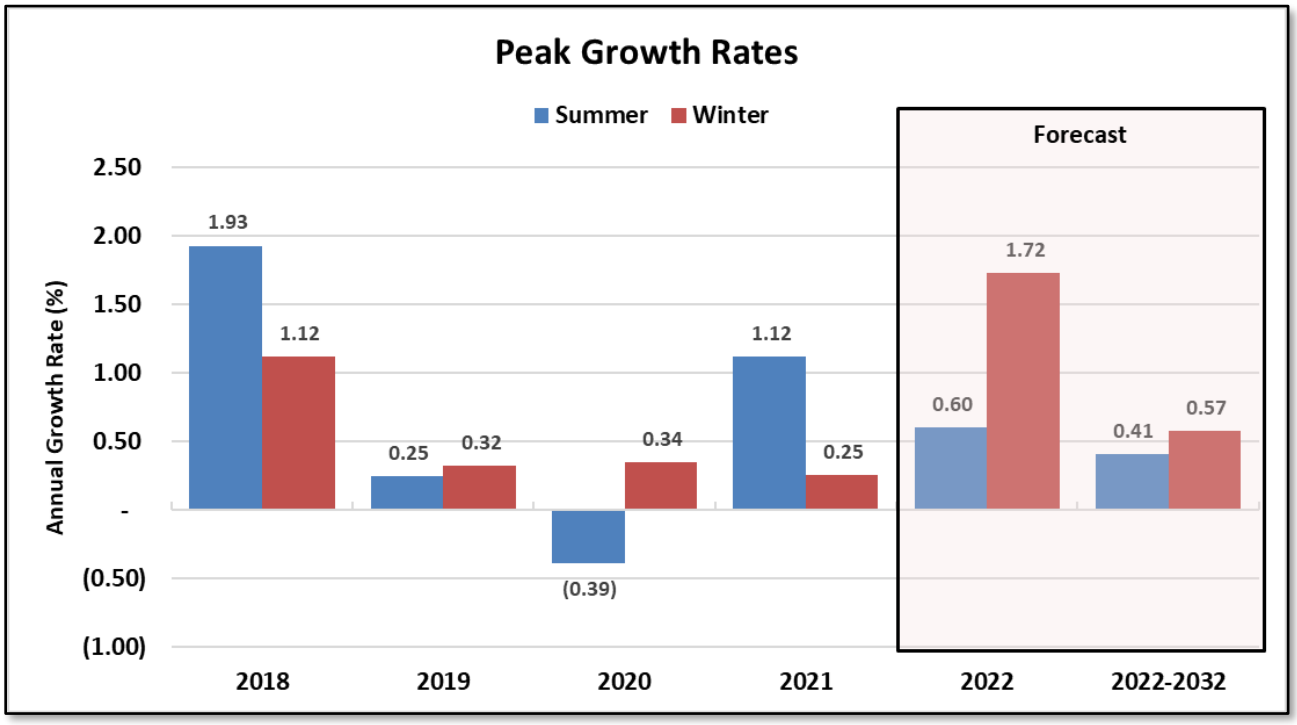
Electric. Weather-normalized system energy increased by 2.02% in 2021. The increase reverses the 2020 sales decline caused by the pandemic. The strong sales growth is attributed to the industrial class growth. Forecast growth continues to be strong with long-term growth (0.64%) higher than the pre-pandemic growth rate (0.27%).

Natural Gas. Weather-normalized natural gas system sales increased by 0.59% in 2021. The increase is driven by commercial class growth and does not fully recover from the pandemic decline. The 2022 forecast growth rate is 1.96% captures the full pandemic recovery. In the long-term growth is expected to be below the pre-pandemic 5-year average growth rate (1.36%).

System Peak Growth

System peak forecast growth is shown in Figure 12. This figure shows historical and forecast peaks for summer and winter peaking companies. Pre-pandemic 5-year average growth rates are not available for historical peak because Itron did not begin asking for summer and winter peak information until 2018. Forecasts include respondents' expectations of the COVID-19 impact and recovery.

Figure 12: Electric Peak Growth



Summer peaks increased 1.12% in 2021. Summer peaks are expected to grow 0.60% in 2022 with the long-term growth rate of 0.41%. Despite the strong 2021 growth, summer peak growth is lower than system sales growth suggesting increasing load factors in the long-term.

Like 2019 and 2020, winter peaks increased by 0.25% in 2021. The forecast winter peak growth is 1.72% in 2021 and 0.57% in the long term. The strong forecast growth is caused by 54% of winter-peaking companies reporting 2022 growth above 2.0%. Long-term growth is consistent with 2019 to 2021 growth rates.

COVID Impacts

Since March 2020, COVID-19 has caused residential sales to increase and commercial, industrial, and system sales to decrease. The largest decreases occurred with the first healthcare orders in March 2020 but have generally waned through 2021. With over 18 months of COVID-19 experience, this year's survey seeks to understand (1) how utilities are managing the COVID-19 effects in the forecasting models and (2) the permanence of COVID-19 effects.

COVID-19 Modelling and Forecasting. With over 18 months of historical COVID-19 impacts, companies must adjust their forecast models to capture the historical COVID-19 data and make assumptions about future impacts. This year's survey asks two modelling/forecasting questions. First, the survey asked companies how they model COVID-19. Second, the survey asked whether companies needed to make further forecast adjustments after modelling.

Figure 13 shows how companies modeled COVID-19. The approaches included in this question are defined below.

- **Binaries**. Binaries are variables that can either (1) remove the impact of a historical data point from the model estimation period or (2) capture an average level shift in the historical estimation period. In both cases, binaries represent the impact of COVID-19 on historical sales.
- **Google Mobility Data**. Google mobility data reports movement trends by geography across different categories such as retail, workplaces, and residential. These data are developed into regression variables that represent COVID-19 impacts on sales.
- **Residual**. Residual variables are created by forecasting sales assuming that COVID-19 did not occur and comparing it with actual data. The residual variable is inserted into a regression model to model the COVID-19 impact.
- **Remove Data**. Removing data assumes the COVID-19 data are outliers. The outliers are removed from the model estimation period and the model forecasts assuming COVID-19 did not occur.
- **Other**. Several companies reported using multiple methods or blending methods to model the COVID-19 effects. One company reported using Moody's "Back-to-Normal" index which is a constructed variable developed by Moody's Analytics that measures how the economy is trending back to pre-COVID-19 levels.

Figure 13: COVID-19 Modelling Approaches

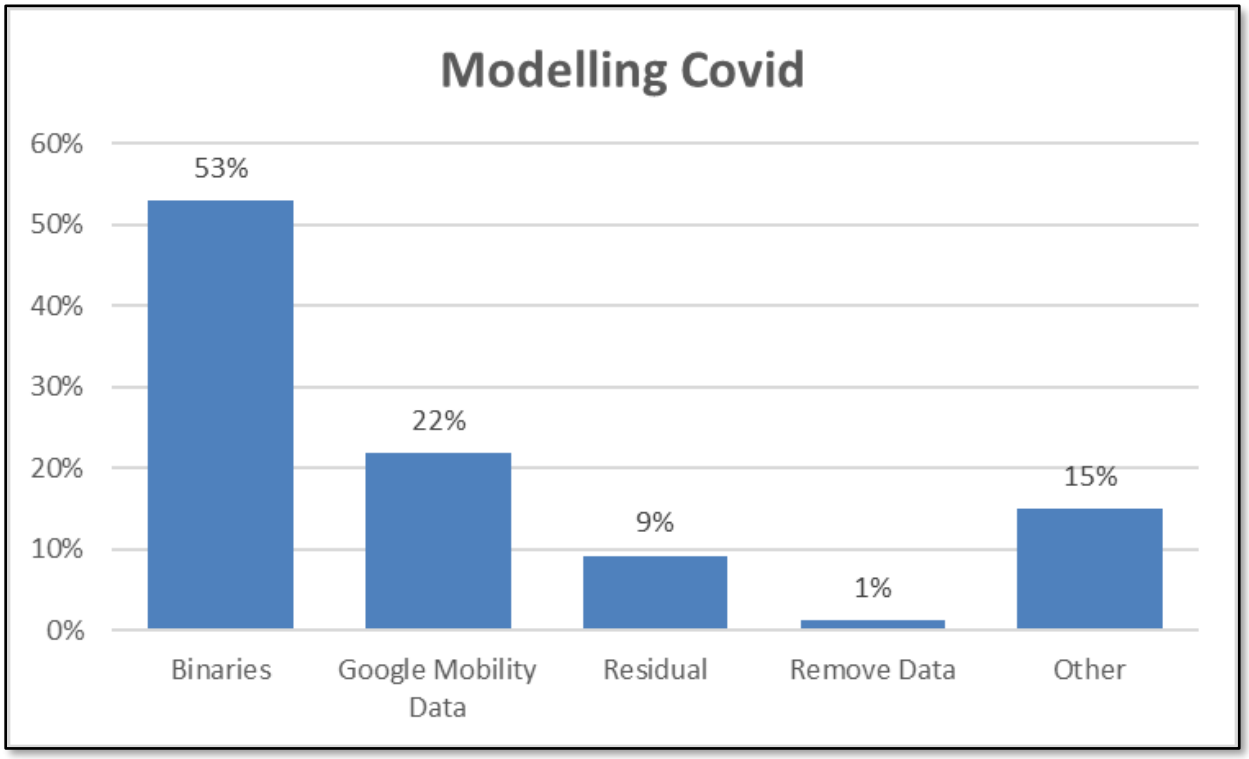
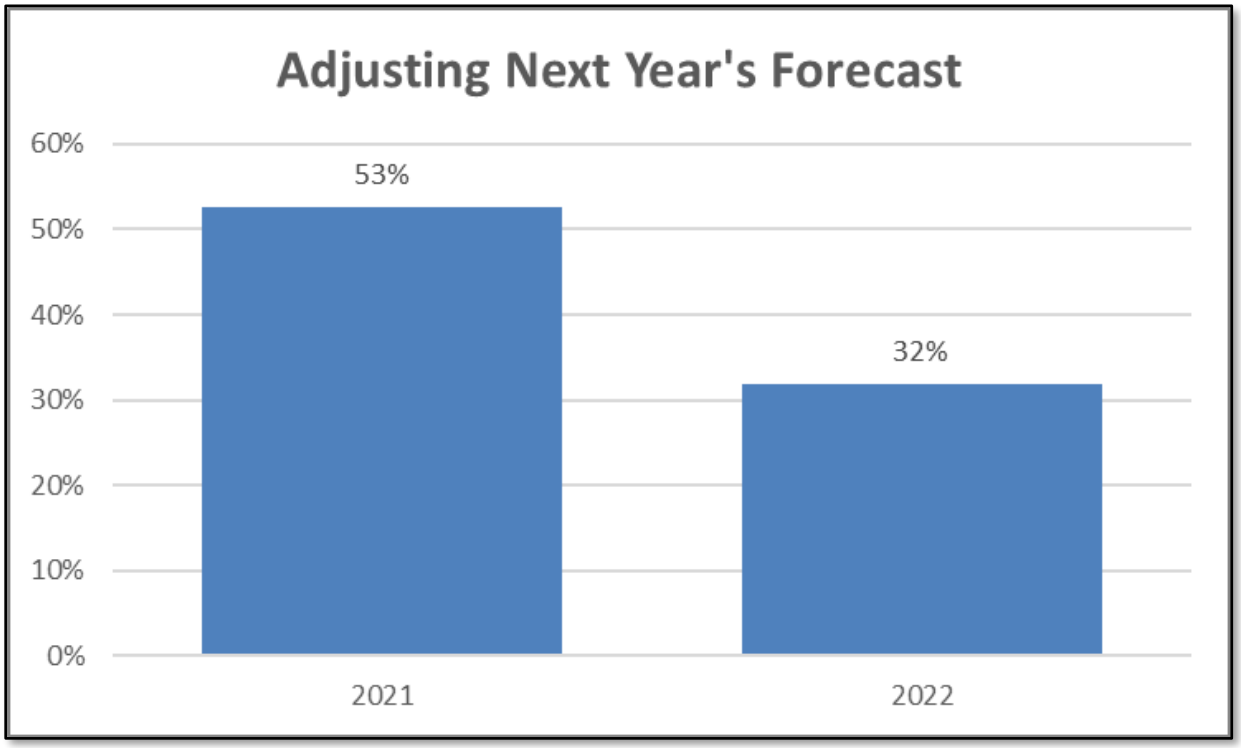


Figure 13 shows that 53% of companies use Binaries, 22% use Google Mobility Data, and 9% use Residuals. The Binaries approach is simple to use and does not require significant analysis to ensure reasonable results. The high number of companies using Binaries shows that a simple approach is preferred over the more complex approaches.

While modelling COVID-19 is important, the statistical models do not always generate reliable results. When model results are not acceptable, companies make manual adjustments to the forecast to match their future expectations. In 2021 and 2022, the survey asked whether companies are making manual adjustments after the statistical modelling process. Figure 14 shows the results.

Figure 14: Manually Adjusting Next Year's Forecast

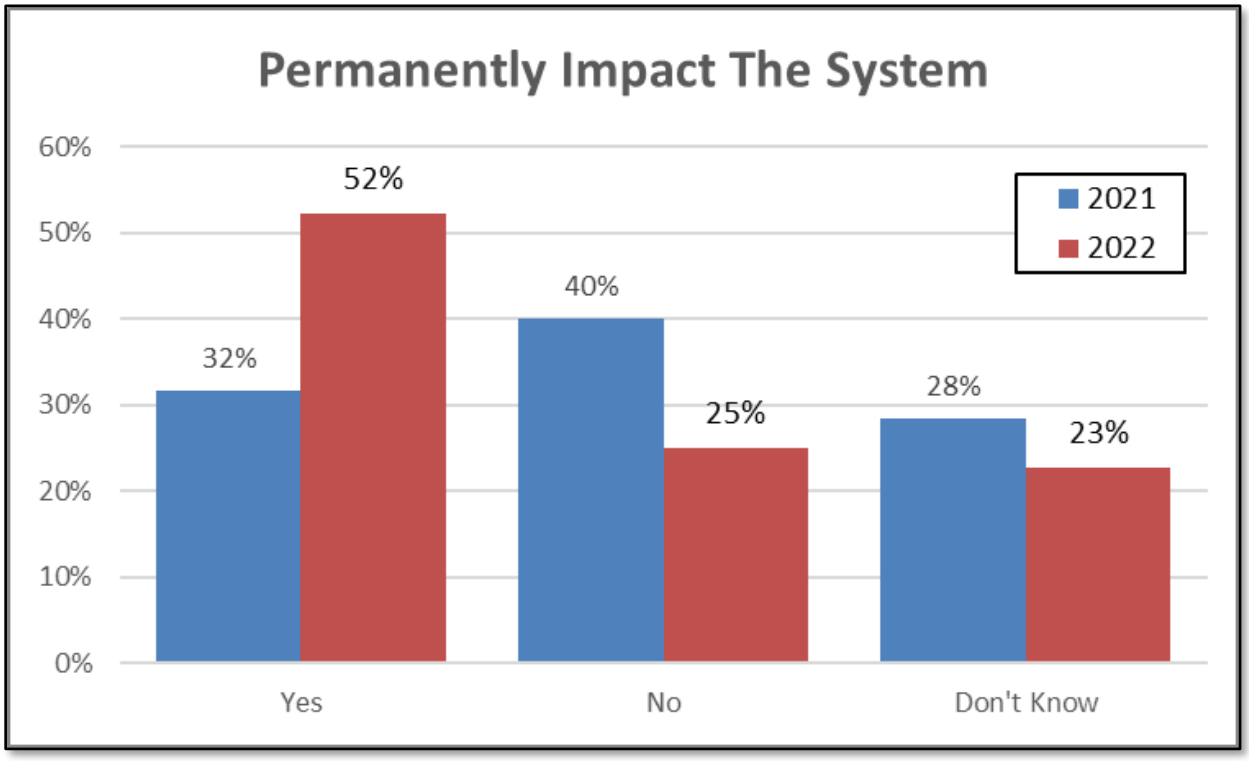


In this figure, the number of companies making manual adjustments reduced from 53% in 2021 to 32% in 2022. The reduction is attributed to (1) improved modelling techniques and (2) declining COVID-19 impacts. As COVID-19 impacts wane, many systems are reverting toward pre-COVID patterns. When this occurs, managing historical COVID-19 data through the techniques shown in Figure 13 are sufficient for managing or removing the COVID-19 effects.

COVID-19 Permanence.

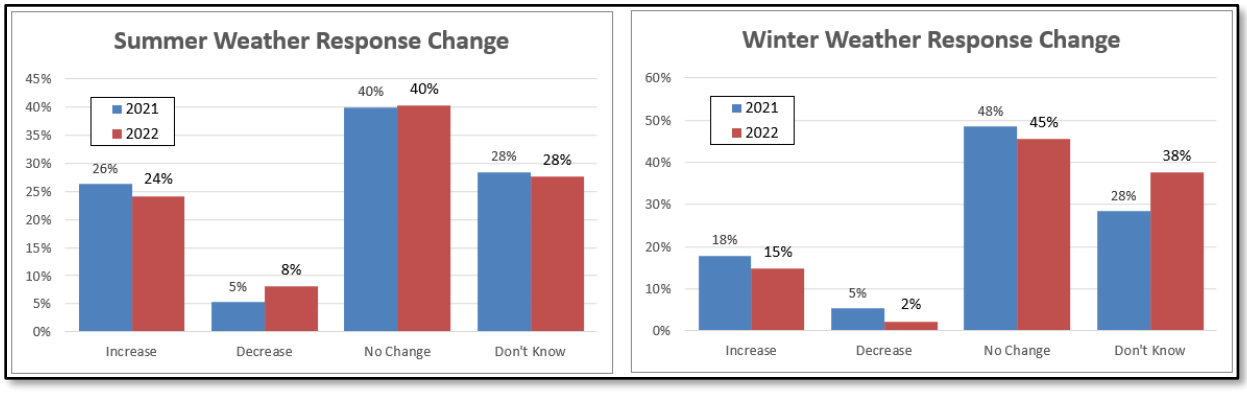
Regardless of the approach used to model COVID-19 impacts, companies still must decide how long the historical impacts will last. This year's and last year's survey asked whether the COVID-19 impacts have permanently changed system demand. Figure 15 shows that 52% of respondents believe that COVID-19 has permanently impacted their energy demand. The response is dramatically higher than the 2021 survey result (32%).

Figure 15: Did COVID-19 Permanently Change System Demand?



While Figure 15 shows that systems are changing, the exact nature of the change is uncertain. One area of potential change is in the system weather response. In other words, are the systems becoming more or less responsive to temperature changes due to COVID-19. Figure 16 shows that 40% of respondents do not think their summer weather response changed and 45% do not think their winter response changed. These responses are consistent with the 2021 responses.

Figure 16: Summer and Winter Weather Response Change



Electric Forecast Accuracy

Three types of errors are reported in the survey. First, companies are asked to compare their 2021 forecast (generated in 2020) against weather normalized 2021 sales. Second, companies are asked to compare the same forecast and against actual 2021 sales. These calculations report errors on an annual basis. For the third calculation, companies are asked to compare the same forecast and report the errors on a monthly average basis.

Annual Forecast Accuracy. The average forecast errors, calculated as the Mean Absolute Percent Error (MAPE), are shown in Figure 17 and Figure 18. The figures show the 2022 MAPE, the 2021 MAPE, and the average annual MAPEs from 2016 through 2020 (pre-pandemic 5-year average). Figure 17 shows the annual forecast errors compared against weather-normalized actual values. Figure 18 shows the annual forecast error compared to actual values. All MAPE values are unweighted.

Figure 17: Annual Electric MAPE - Forecast Versus Weather Normal Actuals

Class	2022 Survey	2021 Survey	2016-2020 Mean
Residential	2.37	3.78	1.59
Commerical	3.09	6.53	1.66
Industrial	3.14	8.32	2.90
System	1.69	3.13	1.43
Peak	3.14	2.76	2.61

Figure 18: Annual Electric MAPE - Forecast Versus Actuals

Class	2022 Survey	2021 Survey	2016-2020 Mean
Residential	2.64	3.53	2.62
Commerical	3.27	6.83	1.67
Industrial	3.48	8.12	2.97
System	1.94	3.65	1.61
Peak	4.67	4.88	3.47

Figure 17 and Figure 18 report that errors are higher than the pre-pandemic average errors and lower than the 2021 survey errors. This result shows the continued challenge of forecasting through the pandemic, but the adaptability of the industry to this new reality. Over time, errors are expected to revert toward the pre-pandemic average.

Monthly Forecast Accuracy. Figure 19 shows the monthly average errors by class with comparative values from prior years' surveys. Like the annual errors, 2022 errors are lower than 2021, but generally higher than prior year results.

Figure 19: Monthly Average Electric Error Results (Unweighted)

Class	2018 Survey	2019 Survey	2020 Survey	2021 Survey	2022 Survey
Residential	3.76	4.26	3.02	6.08	4.48
Commerical	3.03	3.45	2.57	7.34	4.62
Industrial	3.87	3.86	4.70	8.88	4.33

Natural Gas Forecast Accuracy

Similar to the electric forecasting errors, natural gas companies are asked to compare their forecast for 2021 (generated in 2020) against actual and weather-normalized sales in 2021. Figure 20 and Figure 21 show the companies' unweighted annual MAPEs. These figures show the 2022 MAPE, the 2021 MAPE, and the average annual MAPEs from 2016 through 2020 (pre-pandemic 5-year average). Figure 22 shows the unweighted monthly MAPEs.

Annual Forecast Accuracy. Figure 20 and Figure 21 show the class forecasting errors. In 2022, all classes report weather normalized and actual errors lower than the pre-pandemic average errors. Unlike the electric industry, natural gas is less impacted by COVID-19 resulting accuracy more consistent with historical performance.

Figure 20: Annual Natural Gas MAPE - Forecast Versus Weather Normal Actuals

Class	2022 Survey	2021 Survey	2016-2020 Mean
Residential	2.40	2.01	2.66
Commerical	3.39	4.78	4.16
Industrial	6.12	6.58	8.20
System	1.58	2.42	4.23

Figure 21: Annual Natural Gas MAPE - Forecast Versus Actuals

Class	2022 Survey	2021 Survey	2016-2020 Mean
Residential	6.04	3.52	8.68
Commerical	4.01	7.60	6.01
Industrial	6.55	8.39	8.19
System	4.44	4.74	7.26

Monthly Forecast Accuracy. Like the annual accuracy, monthly accuracy is consistent with prior year results. Monthly forecast accuracy is considerably higher than annual accuracy because variations in monthly errors are not offset when aggregated to the annual totals. The monthly MAPEs are shown in Figure 22.

Figure 22: Monthly Average Gas Error Results (Unweighted)

Class	2018 Survey	2019 Survey	2020 Survey	2021 Survey	2021 Survey
Residential	7.28	6.82	9.87	11.96	10.20
Commerical	6.68	8.84	10.98	12.12	8.08
Industrial	10.17	10.33	13.58	8.38	11.58

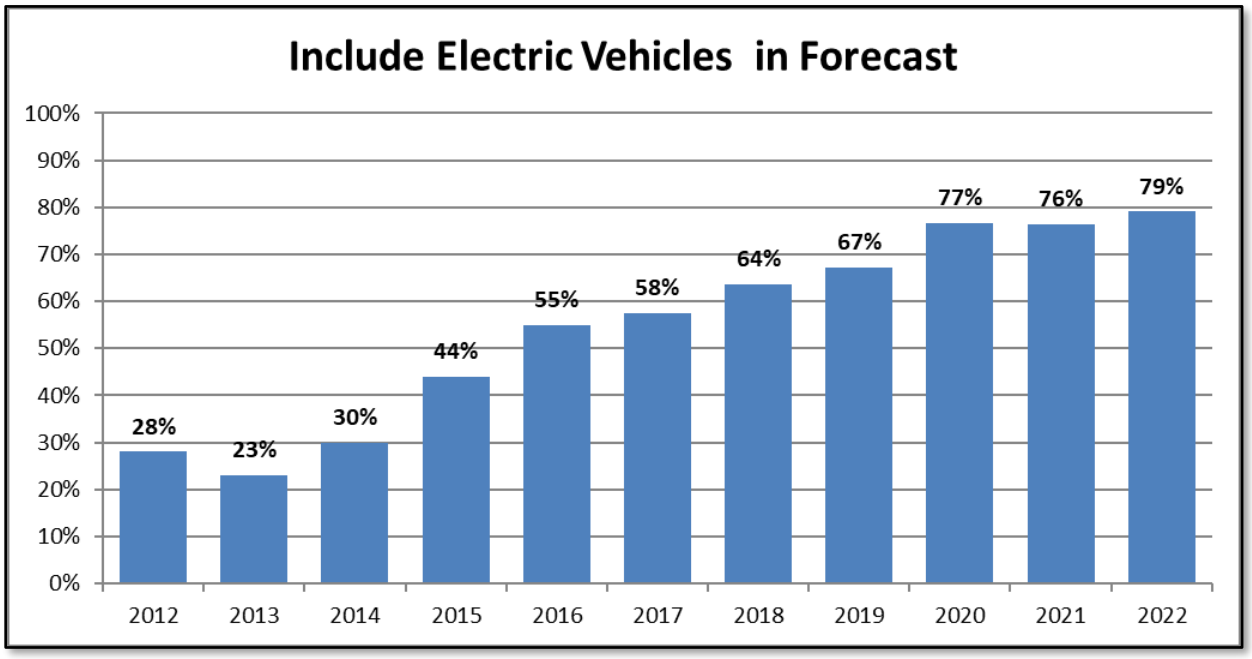
Key Forecast Characteristics

As part of the annual survey, Itron tracks changes in forecasting practices. This year, these changes include accounting for new technologies, normal weather calculations, and economic driver data.

Electric Vehicles

Figure 23 shows the percentage of companies that explicitly include electric vehicles (EVs) in their forecast. Since 2020, almost 80% of respondents are including EVs in their forecasts.

Figure 23: Include Electric Vehicles in the Forecast

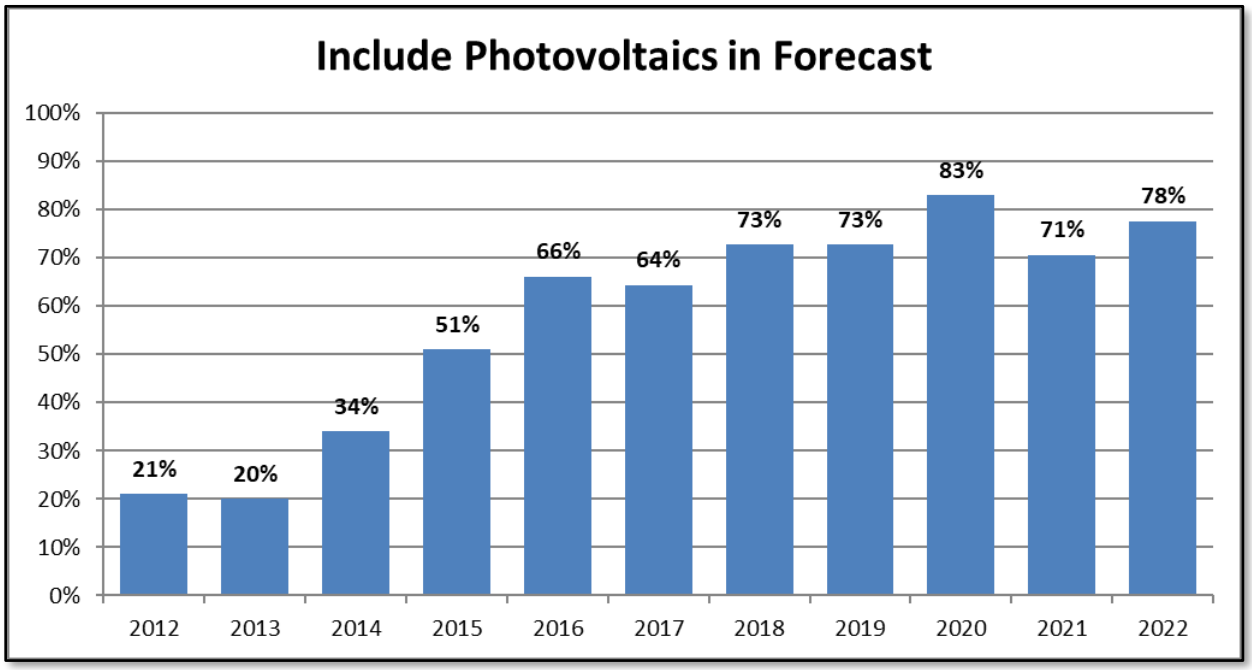


The large number of companies including EVs in their forecasts highlight the potential impact of this new technology. In August 2021, President Biden outlined a target of 50% of vehicle sales will be electric by 2030. In August 2022, California established a roadmap so that 100% of new car sales and truck sold in California will zero-emission by 2035. Currently, seventeen states have vehicle emission standards tied to rules established in California. With these new targets and mandates, forecasting EV impacts is becoming necessary.

Photovoltaics.

Figure 24 shows the share of companies that include photovoltaics (PV) in their forecast. This year, 78% of respondents include PV forecasts in their forecasts. Since 2018, over 70% of companies forecast PVs making its inclusion a standard practice among utilities.

Figure 24: Include Photovoltaics in the Forecast

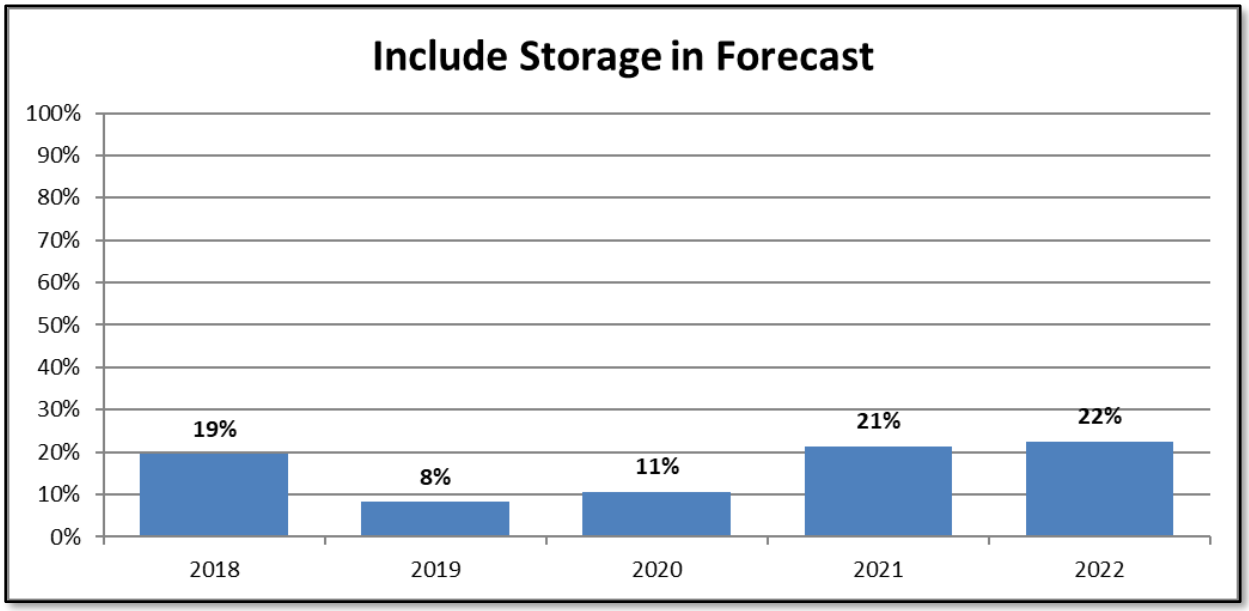


PV continues to be a key variable forecasting electric sales. According to Solar Energy Industries Association (SEIA), the total installed PV capacity in the United States is 130.9 GW. With the Inflation Reduction Act, SEIA expects PV installations to increase by 40% or 62 GW over the next five years. With strong expected growth in PV, capturing PV generation in the sales forecast is essential.

Electric Battery Storage

The storage market continues to be in the nascent stages making forecasting technology penetration and usage patterns difficult. As with any new technology, companies should closely monitor the market to identify signs and factors that will assist them in forecasting this technology. Figure 25 shows only 22% of companies are including battery storage in their forecasts. The percentage has not significantly changed since the survey began asking this question in 2018.

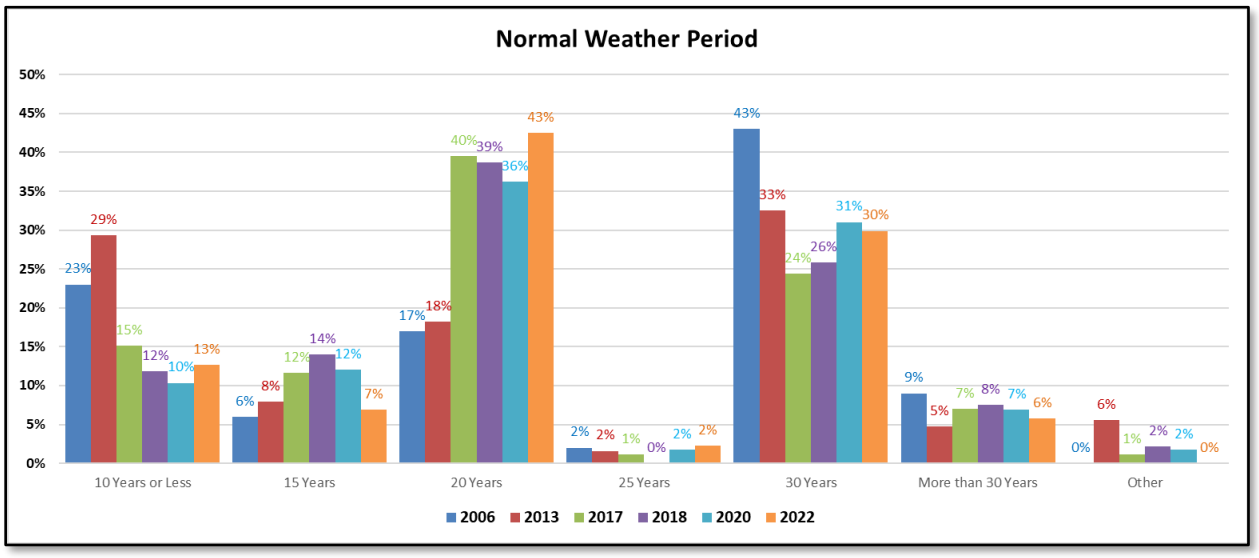
Figure 25: Include Battery/Storage in the Forecast



Normal Weather.

The 2022 survey asked respondents how many years of historical weather data they use to calculate normal weather. These results are combined with Itron's 2006, 2013, 2017, 2018, and 2020 survey results and presented in Figure 26.

Figure 26: Normal Weather Calculation Period



Historically, companies have favored 30-year averages to represent normal weather. In 2006, 43% of companies used the 30-year average. In 2013, the survey shows movement away from the 30-year average toward the 10-year average. Beginning in 2017, the 20-year average becomes the dominant

normal weather period. In the 2017, 2018, 2020, and 2022 surveys, over 36% of the companies reported using the 20-year average.

In the 2022 survey, Itron asked two questions to understand how companies are managing climate change issues. First, Itron asked whether companies are adjusting their normal weather for climate change. Second, Itron asked how companies are adjusting their normal weather for climate change. These results are shown in Figure 27 and Figure 28.

Figure 27: Normal Weather Climate Change Adjustment

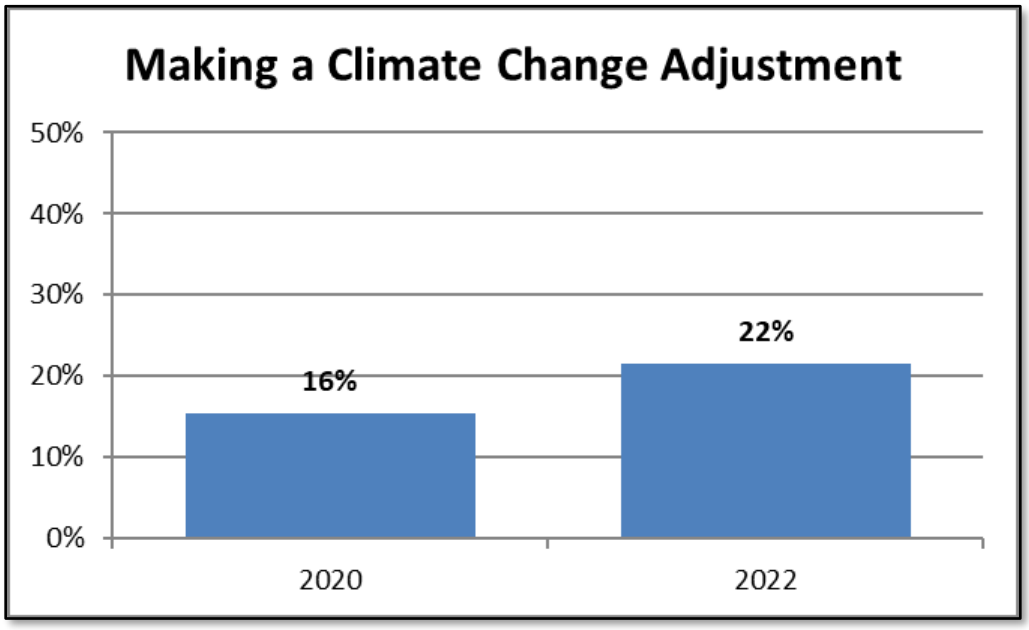


Figure 27 shows that 22% of companies are adjusting their normal weather for climate change. Like the 2020 survey results, few companies are making adjustment. Of the companies making adjustments, Figure 28 shows how companies are making the adjustment.

Figure 28: Normal Weather Climate Change Adjustment Method

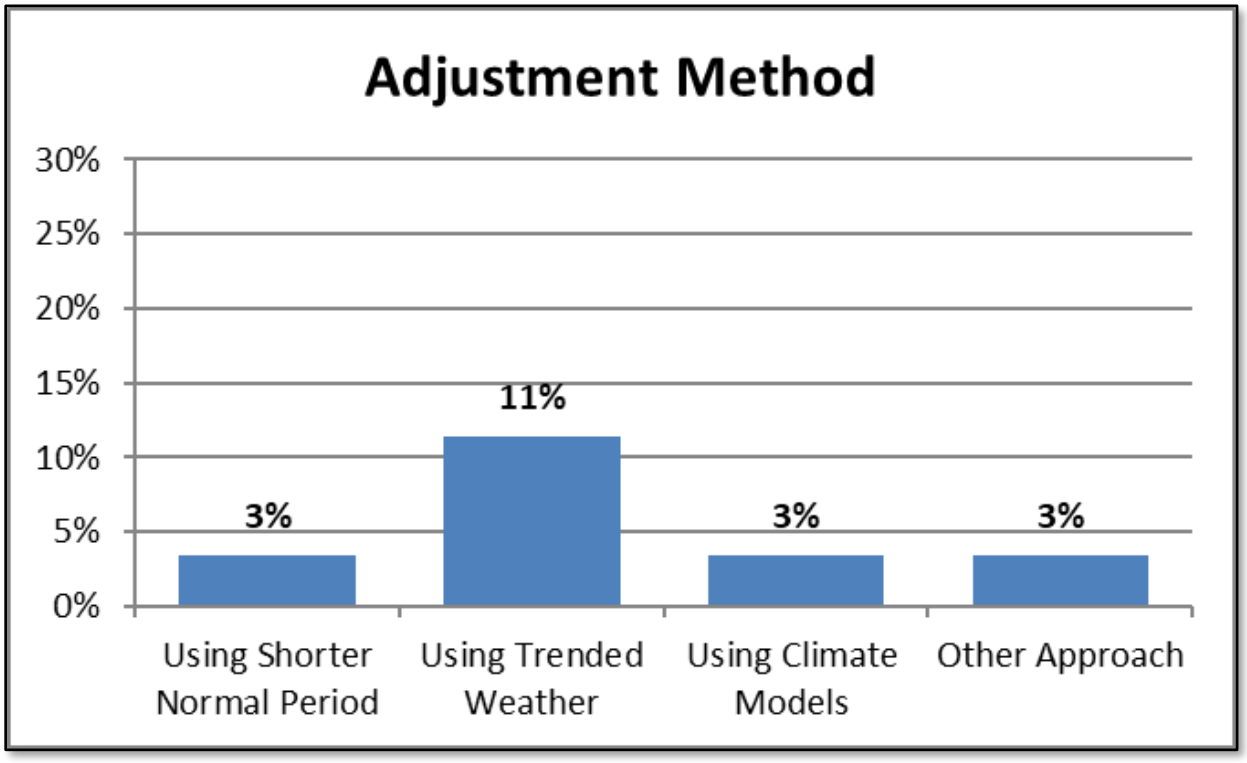


Figure 28 shows the three main methods for adjusting normal weather.

- **Using Shorter Normal Period**. The simplest method for adjusting normal weather is to calculate normal weather using fewer historical years. By shortening the historical period, more recent weather data dominates the normal weather calculation.
- **Using Trended Weather**. The trend approach applies a growth trend to the existing normal weather calculation. The trend is developed my estimating how historical temperatures are changing over time and then applying that change in the forecast period.
- **Using Climate Models**. Sophisticated climate models simulate surface, atmospheric, and ocean conditions to predicted how the earth's climate is changing. These models generate a long-term forecast of future temperatures. Climate model results may be transformed into variables that are used in the forecast models.

Of these methods, most companies make their climate adjustments using the Trended Weather approach. This approach is more complex than adjusting the normal period, but simpler than working with Climate Model results.

Economic Data.

Historical and forecast economic data are essential the long-term forecasting process. In 2012, Itron asked companies to list their main economic drivers for the residential, commercial, and industrial classes. This year, the survey re-asks the question to obtain an updated list of key drivers. These drivers are listed in Figure 29, Figure 30, and Figure 31. These figures show the number of times each driver is

identified among the 88 respondents. The large number of identified drivers indicates that most companies use multiple drivers for each class.

Figure 29: Residential Economic Drivers

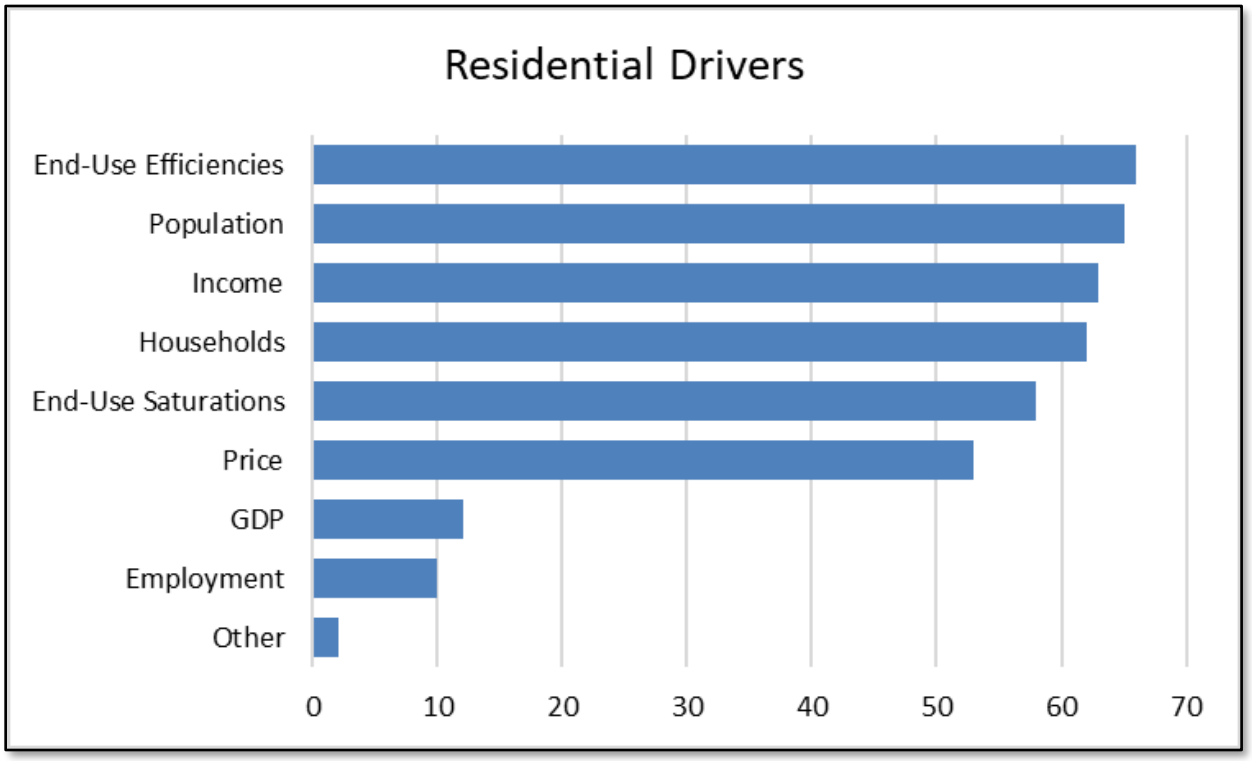


Figure 29 identifies the population, households, income, and end-use information (saturations and efficiencies) as key residential drivers. Population and households are typically used to forecast customer formation. Income and end-use information are typically used to model how residential customers use energy.

Figure 30: Commercial Economic Drivers

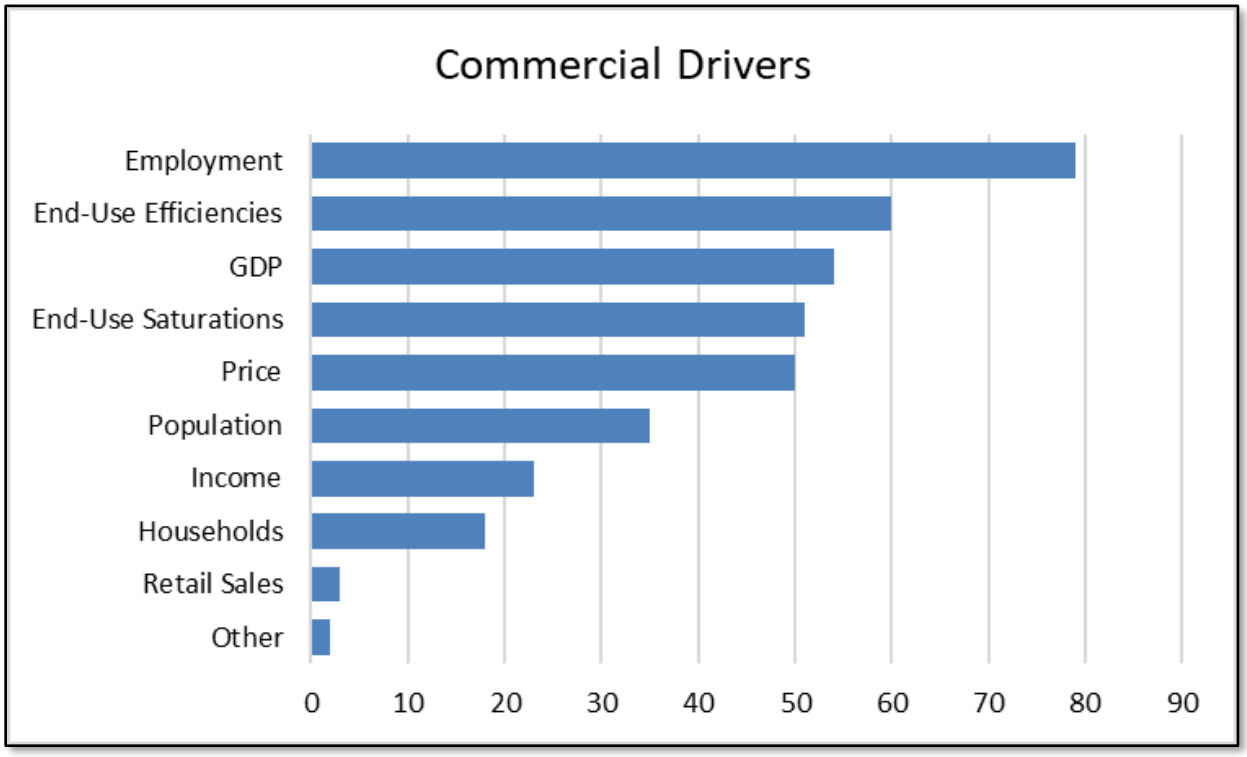


Figure 30 identifies the employment, end-use information (saturations and efficiencies), GDP, and Price are the key commercial economic drivers. Employment and GDP capture regional growth and end-use information models how commercial customer use energy.

Figure 31: Industrial Economic Drivers

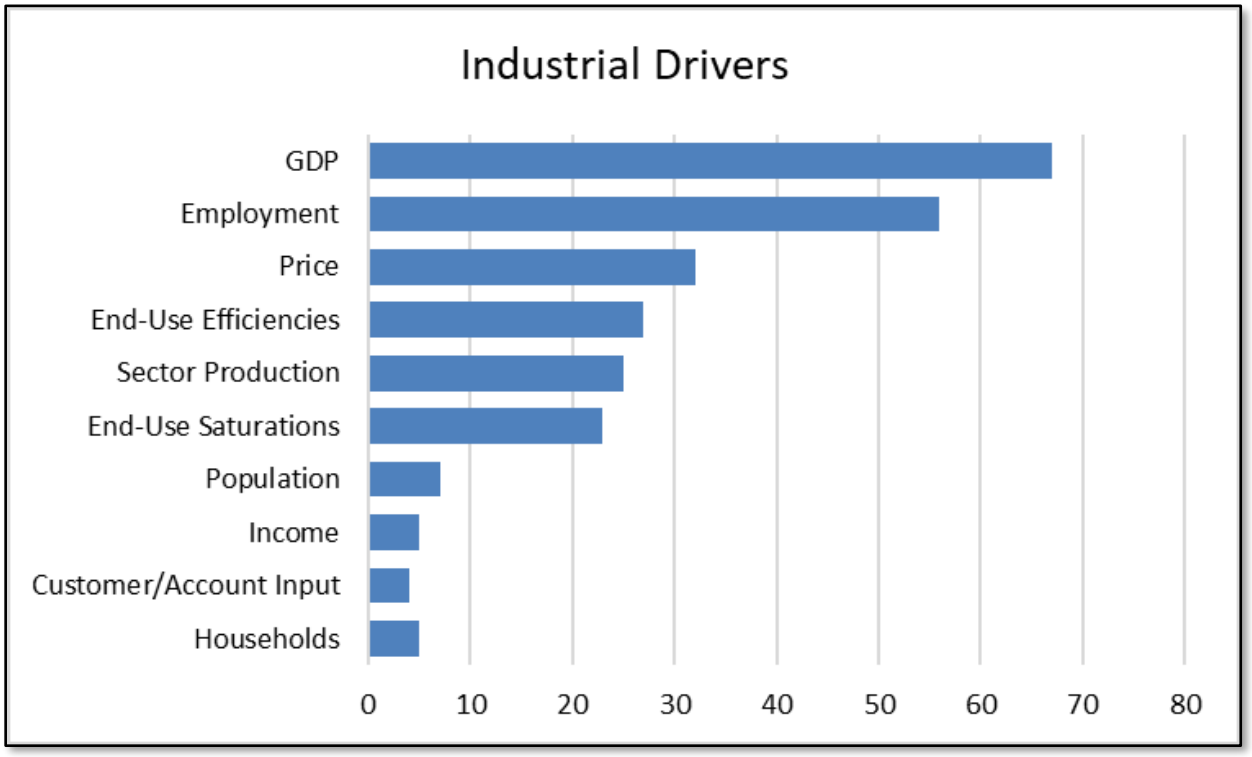
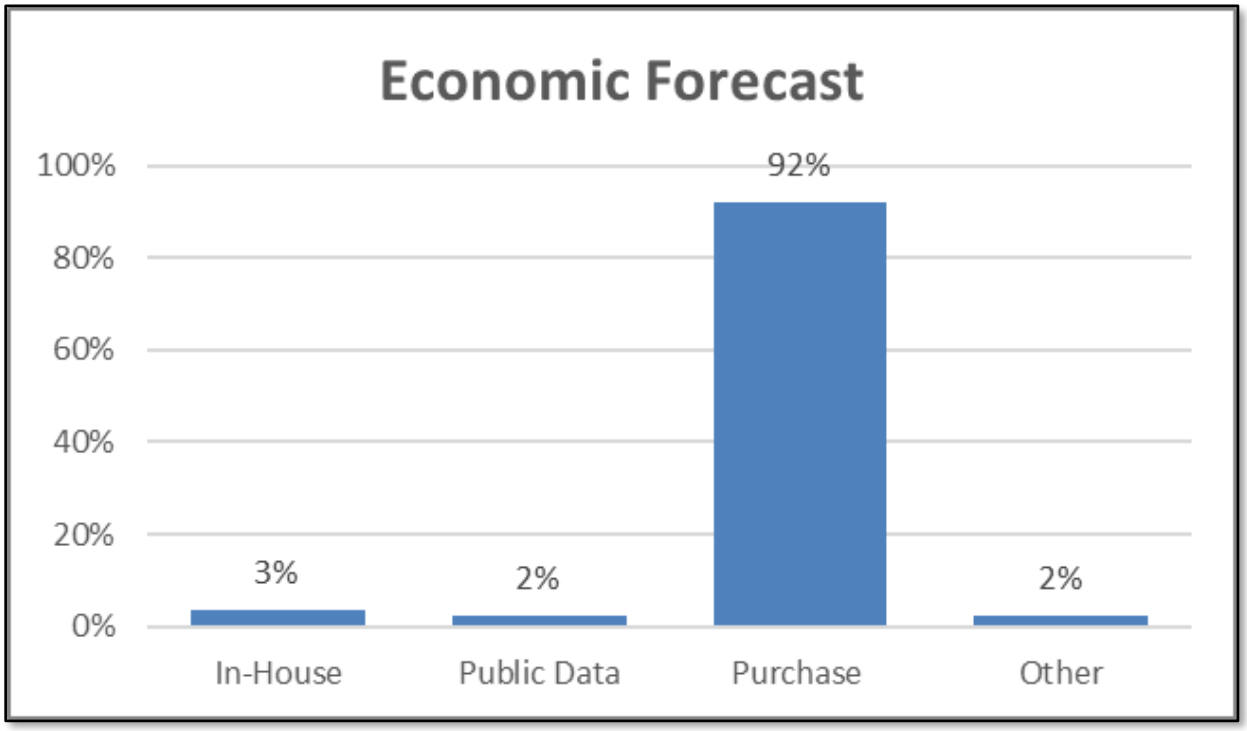


Figure 31 shows that the industrial class is primarily modelled with GDP and employment. Both GDP and employment capture the input and output to the industrial manufacturing processes.

Companies generally obtain their economic data from an economic vendor. Figure 32 shows that 92% of respondents acquire their economic data. Very few companies seek to use publicly available data or develop the economic data themselves.

Figure 32: Economic Forecast Source



Conclusion

The 2022 survey captures the industry's movement back toward pre-pandemic growth patterns. While electric growth is expected to return to pre-pandemic levels in 2023, uncertainty remains about whether COVID-19 has permanently impacted sales. In the long term, electric growth rates are expected to remain higher than the pre-pandemic growth rates. Natural gas forecast growth is expected to return to pre-pandemic levels in 2022, but with lower long-term growth rates than the pre-pandemic growth rates.

Companies are adapting their forecast models to manage the COVID-19 effect. The adaptations are reducing forecast error but have not yet produced error levels at pre-pandemic levels. The uncertainty of COVID-19's permanence continues to make forecasting challenging and requires further analysis and careful monitoring.