2021 Forecasting Benchmark Survey

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Since 2012, Itron's annual benchmarking survey has reported a broad picture of the electric and gas industry's forecasting practices. Like prior years, the 2020 survey examines forecast accuracy, growth projections, and forecast characteristics.

Unlike prior years, this year's survey seeks to understand the impact of COVID-19. Additional questions document the COVID-19 sales impacts on each sector and forecasters' perceptions of how COVID-19 is changing our electric systems.

The survey collects data from February through July and culminates with this report in the fall. This year, 98 companies responded to the survey representing over 2.6 billion kWh of electricity and 1.0 BCF of natural gas. Figure 1 shows the number of survey responses for 2021 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

This report includes the following sections.

- Forecast Accuracy Overview
- Electric Forecast Growth Overview
- Natural Gas Forecast Growth Overviews
- Customer Growth
- Residential Sales Growth
- Commercial Sales Growth
- Industrial Sales Growth
- System Sales Growth
- System Peak Growth
- COVID Impacts
- Electric Forecast Accuracy
- Natural Gas Forecast Accuracy
- Key Forecast Characteristics

Forecast Accuracy Overview

Since 2012, this Itron has asked companies to provide forecast accuracy statistics. While this year's survey continues to ask for the same information, the results are significantly 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. For example, the electric residential sales error increased to 3.78% from its recent historical average of 1.88%. Likewise, electric commercial sales error increased to 6.53% from its recent historical average of 2.30%. Detailed accuracy statistics are shown in Figure 16 and Figure 19. Due to the range of COVID-19 healthcare orders and their durations, companies should use caution when benchmarking their performance against survey results. Survey results represent a wide variety of COVID-19 situations across North America.

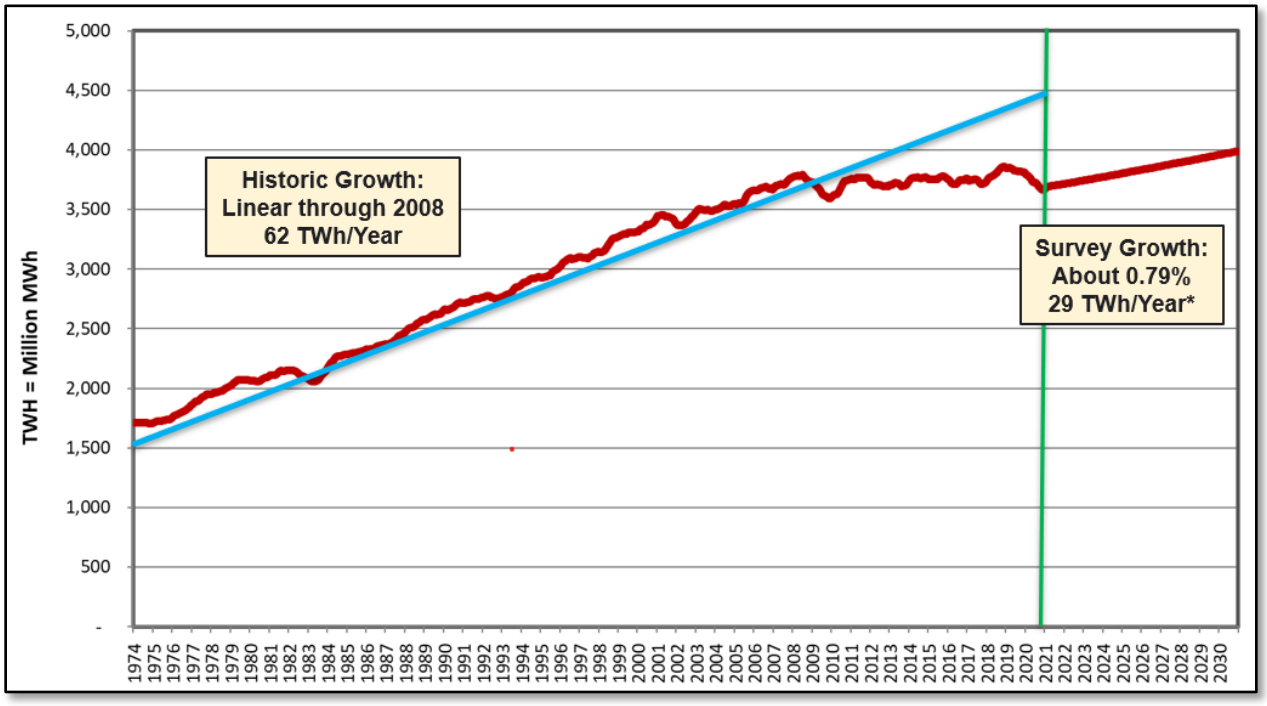
Electric Forecast Growth Overview

Like the backward-looking accuracy results, electric growth forecasts are significantly impacted by COVID-19. The COVID-19 stay-at-home orders shifted electric consumption from the commercial and industrial sectors to the residential sector. This shift is unprecedented and continues to have lingering impacts through 2021 and into the forecast period. In 2020, residential sales increased by 3.80%, a significant jump relative to the prior 5-year average growth of 0.27%. Likewise commercial sales declined 4.95%, compared to prior 5-year average growth increase of 0.35%. Overall, the drops in business sales outweighed the gains in residential sales, with total weather adjusted sales estimated to have declined by 1.14%.

Following a disturbance of this size, forecast growth rates are expected to show a "snap-back" effect with higher-than-average growth rates for total sales in 2021 and a range of trajectories back toward the long-term growth rates. The size of the snap-back and the duration of the recovery trajectories capture companies' expectations around the lasting impact of COVID-19. Figure 8 through Figure 12 show expected growth rates for 2021 and the long-term forecast growth rates.

Figure 2 shows historical sales from 1974 through 2020 as 12-month rolling sums. The red line shows historic sales through 2020 with forecast sales growth through 2030 based on the survey results. The blue lines show the long-term growth trend through 2008 and extrapolated from 2009 through the forecast period. This figure shows the immediate impact from COVID-19 and the multiyear return to normal patterns in the forecast period

Figure 2: Survey Electric Sales Growth

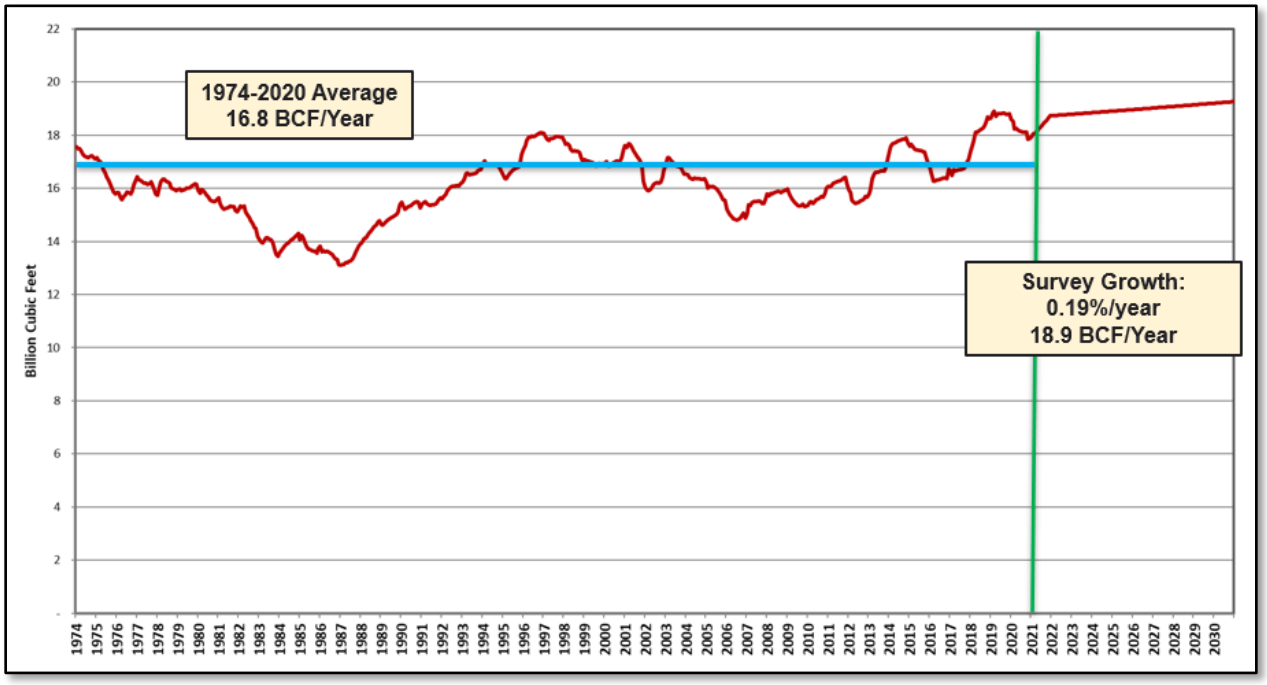


Natural Gas Forecast Growth Overview

2020 Natural gas sales were impacted less by COVID-19 than electric sales. 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). As a result, residential natural gas growth is in line with historical patterns. However, commercial and industrial natural gas sales were reduced due to the economic slowdown associated with COVID-19 healthcare orders. Forecasted natural gas sales show a quick return to normal growth with strong snapback characteristics in 2021. The historical and forecast growth is shown on the bottom line in Figure 8 through Figure 12.

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 immediate impact from COVID-19 and the quick return to normal patterns in the forecast period.

Figure 3: U.S. Historical Natural Gas Sales

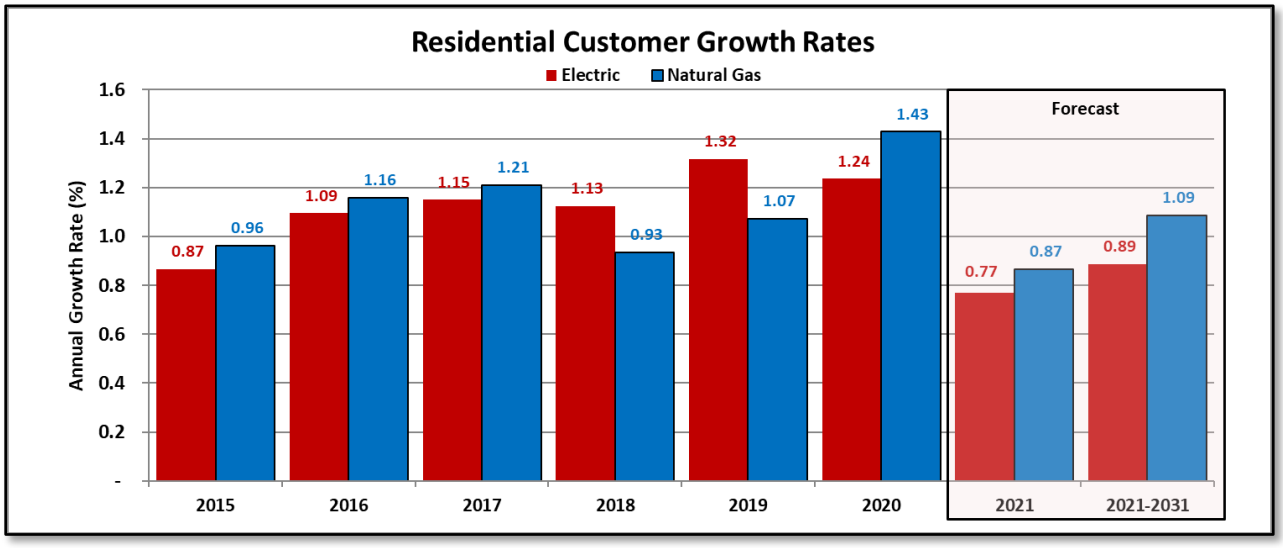


Customer Growth

Historical and forecast customer growth rates for the residential and commercial classes are shown in Figure 4 and Figure 6. Forecast growth rates for 2021 and the long term (2021-2031) are highlighted. Forecasts include respondents' expectations of COVID-19 impacts. For comparative purposes, growth rates from the 2015 through 2020 surveys are displayed with the 2021 survey results.

Residential Customer Growth. Figure 4 shows residential customer growth rates for electric and natural gas respondents. In 2020, electric customers grew 1.24% and natural gas customers grew 1.43%.

Figure 4: Residential Average Customer Growth (%)



The 2020 electric customer growth does not appear to be impacted by COVID-19. The 2020 growth rate is within the historical range (0.87% to 1.32%) of growth. However, companies have lowered their growth expectations in 2021 and in the long term (2021-2031) below the pre-pandemic 5-year (2015-2019) average growth rates of 1.11%.

Natural gas residential customer growth is strong in 2020 (1.43%) with a significantly slower forecast in 2021 (0.87%). However, the long-term forecast is close to the pre-pandemic 5-year average growth rate of 1.07%.

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 growth in Canada.

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

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Forecast 2021	Forecast 2021-2031
Canada	0.81	1.21	1.04	0.94	0.96	1.12	0.96	0.92
Midwest	0.55	0.82	0.77	0.61	0.72	0.92	0.14	0.48
Northeast	0.27	0.40	0.57	0.72	0.61	0.29	0.04	0.24
South	1.30	1.21	1.35	1.43	1.67	1.61	1.10	1.02
West	1.05	1.43	1.49	1.32	1.45	1.54	1.20	1.51
Total Electric	0.87	1.09	1.15	1.13	1.32	1.24	0.77	0.89
Natural Gas	0.96	1.16	1.21	0.93	1.07	1.43	0.87	1.09

This year's survey asked whether companies made additional changes to their 2021 residential customer forecasts beyond normal model updates (i.e., updated economics and historical data) in response to COVID-19. Only 10% of respondents made additional changes. Of these respondents, only 1 respondent decreased its residential customer forecast.

The changes to the residential customer forecasts range between decreasing the forecast by 0.03% to increasing the forecast by 2.8% The weighted average increase in forecast growth is 0.43%. The low number of respondents changing their forecasts suggests that customer growth is accurately captured with an updated economic forecast.

Commercial Customer Growth. Figure 6 shows commercial customer growth rates for electric and natural gas respondents. In 2020, electric customers grew 0.78% and natural gas customers grew 0.53%. The 2020 customer growth is generally consistent with the pre-pandemic 5-year (2015-2019) average growth rates of 0.92% for electric customers and 0.57% for natural gas customers.

The electric customer forecast growth rates for 2021 and the next 10-years are 0.85% and 0.79% respectively. The forecast growth rates are slightly lower than the pre-pandemic 5-year average growth rate.

The natural gas forecasts show a surprising decline (0.52%) in 2021 with a rebound in growth slightly higher than the pre-pandemic 5-year average over the next 10-years (0.74%). In 2021, 60% of natural gas respondents forecast a decline in 2021 likely caused by COVID-19's impact on the commercial sector.

Figure 6: Commercial Average Customer Growth (%)

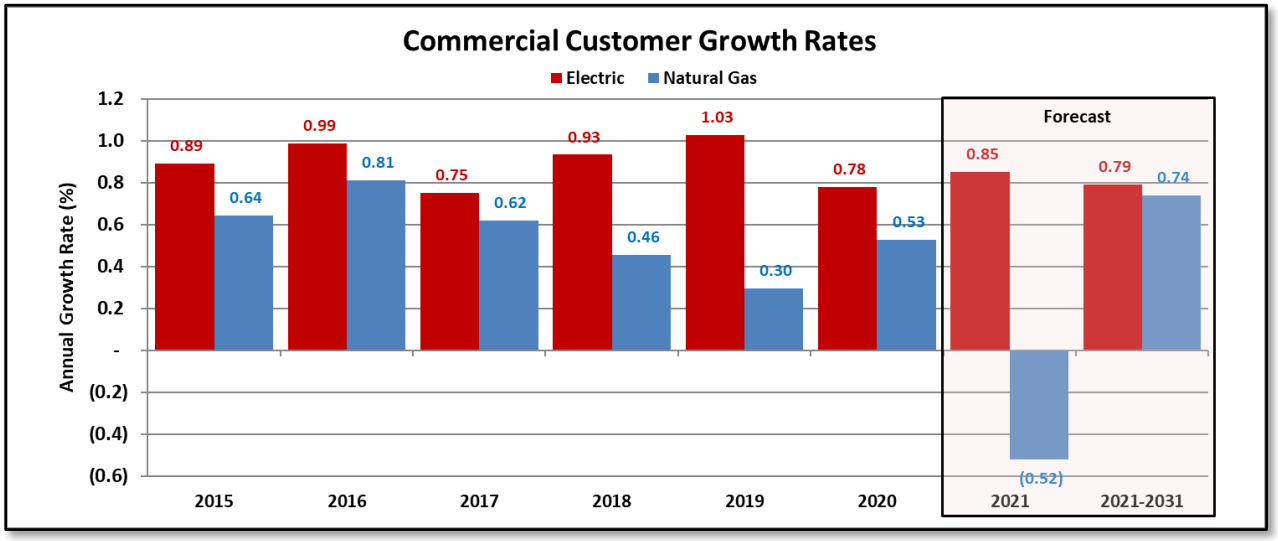


Figure 7 shows the regional growth rates. The figure shows the continued pattern of stronger commercial customer growth in the South and West relative to the Northeast and Midwest regions, and consistent growth in Canada.

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

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Forecast 2021	Forecast 2021-2031
Canada	0.68	0.94	0.25	0.45	0.47	0.55	0.57	0.56
Midwest	0.83	1.08	0.71	0.66	0.72	0.46	1.37	0.51
Northeast	0.51	1.10	0.53	0.50	0.54	0.14	0.37	0.44
South	1.19	0.91	1.17	1.24	1.35	1.16	0.94	1.03
West	1.02	1.27	0.16	0.91	0.89	1.06	0.49	1.14
Total Electric	0.89	0.99	0.75	0.93	1.03	0.78	0.85	0.79
Natural Gas	0.64	0.81	0.62	0.46	0.30	0.53	(0.52)	0.74

This year's survey asked whether companies made additional changes to their 2021 commercial customer forecasts beyond the normal model updates (i.e., updated economics and historical data) in response to COVID-19. Only 11% of respondents made additional changes. Of these respondents, 50% increased their forecast and 50% decreased their forecast.

The changes to the commercial customer forecasts range between decreasing the forecast by 2.0% to increasing the forecast by 1.0% The weighted average decrease in the commercial customer forecast is 0.38%. The low number of respondents changing their forecasts suggests that customer growth is accurately captured with an updated economic forecast.

Residential Sales Growth

Figure 8 shows the history of survey results for weather normalized residential sales growth rates. Additionally, the figure shows the 2021 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average growth rate. Forecasts include respondent's expectations of future COVID-19 impacts.

Figure 8: Residential Sales Growth

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Forecast 2021	Forecast 2021-2031	Average 2015-2019
Canada	(0.97)	1.12	0.79	1.37	1.02	2.90	1.55	0.63	0.66
Midwest	(1.24)	(0.15)	(0.45)	0.09	0.19	3.71	(3.15)	0.36	(0.31)
Northeast	(1.25)	0.09	0.27	1.27	(0.57)	4.54	(3.07)	0.22	(0.04)
South	1.27	0.12	0.07	1.85	(0.22)	4.12	(0.61)	0.75	0.62
West	(1.11)	1.29	0.80	0.18	(0.10)	4.09	(0.55)	0.83	0.21
Electric Total	(0.38)	0.33	0.16	1.19	0.03	3.80	(0.84)	0.61	0.27
Itron WN	0.31	0.17	0.74	0.62	(0.42)	4.62			0.28
Natural Gas Total	(0.72)	0.91	1.53	(1.88)	1.08	1.15	(0.46)	0.64	0.19

Electric. Weather normalized residential sales grew 3.80% in 2020. The high growth rate relative to historical levels is a result of healthcare policy orders issued in response to COVID-19. These orders prompted companies to implement work-from-home policies resulting in higher residential consumption. The forecast for 2021 shows a decrease of 0.84% reflecting a partial return to normal practices, but not a reversion back to pre-pandemic levels. The long-term growth rate of 0.61% is higher than the pre-pandemic 5-year average growth rate implying a persistent change in growth patterns resulting from the pandemic.

For comparative purposes, Itron weather normalizes United States sales based on EIA data. Itron's weather normalized sales are preliminary because the EIA updates its data at the end of the year. In 2020, Itron shows a weather normalized growth rate of 4.62%.

This year's survey asked whether companies made additional changes to their 2021 residential sales forecasts beyond the normal model updates (i.e., updated economics and historical data) in response to COVID-19. 30% of respondents made additional changes. Of these respondents, 57% increased their forecast and 43% decreased their forecast.

The changes range between decreasing the forecast by 5.4% to increasing the forecast by 16.2% with the weighted average change being an increase of 0.57%. The large number and wide range of forecast adjustments imply that the current models are struggling to capture future expectations of COVID-19 impacts.

Natural Gas. Weather normalized residential natural gas sales increased 1.15% in 2020. The growth is higher than the pre-pandemic 5-year average (0.19%) but within the range of historical results. Despite the higher growth rate, it is unclear whether the strong growth was due to the COVID-19 response or

within the natural variance of the survey responses. However, the 2021 forecast shows a decline (0.46%) suggesting that the survey respondents view the high 2020 growth rates as COVID-19 related.

While this year's survey asked whether gas companies made additional changes to their 2021 residential forecast, only 1 gas company reported making a change. This change increased residential sales by 0.34%.

Commercial Sales Growth

Figure 9 shows past and current reported weather normalized commercial sales growth rates. Additionally, the figure shows the 2021 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average growth rate. Forecasts include respondent's expectations of COVID-19 impacts.

Figure 9: Commercial Sales Growth

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Forecast 2021	Forecast 2021-2031	Average 2015-2019
Canada	0.51	1.14	0.51	1.86	0.81	(4.00)	0.01	1.30	0.97
Midwest	(0.48)	0.03	0.13	0.06	(1.22)	(4.91)	0.61	0.17	(0.30)
Northeast	(0.58)	(0.47)	(0.47)	(0.07)	(0.82)	(7.35)	(1.69)	(0.71)	(0.48)
South	1.07	0.24	0.24	1.88	(0.47)	(5.09)	3.70	0.92	0.59
West	0.43	0.24	0.24	0.55	(0.24)	(4.70)	3.49	1.26	0.24
Electric Total	0.28	0.32	0.32	1.25	(0.42)	(4.95)	1.67	0.78	0.35
Itron WN	0.04	(0.07)	(0.01)	1.34	(1.03)	(5.82)			0.05
Natural Gas Total	(0.58)	0.69	3.99	(1.04)	2.13	(2.97)	3.83	0.95	1.04

Electric. Weather normalized commercial sales declined 4.95% in 2020. The decline is a result of healthcare policy orders and business closures in response to COVID-19. The forecast for 2021 shows an increase of 1.67% reflecting a partial return to normal practices, but not a reversion back to pre-pandemic levels. The long-term growth rate of 0.78% is higher than the pre-pandemic 5-year average growth rate (0.35%) creating a trend toward pre-pandemic sales levels over the next 4 years with stronger growth projected through the decade.

For comparative purposes, Itron weather normalizes United States sales based on EIA data. Itron's weather normalized sales are preliminary because the EIA updates its data at the end of the year. In 2020, Itron shows a weather normalized decline of 5.82%.

This year's survey asked whether companies made additional changes to their 2021 commercial sales forecasts beyond the normal model updates (i.e., updated economics and historical data) in response to COVID-19. 28% of respondents made additional changes. Of these respondents, 46% increased their forecast and 54% decreased their forecast.

The changes range between decreasing the forecast by 41.6% to increasing the forecast by 9.6% with the weighted average change being a decrease of 2.47%. Like the residential sales results, the large

number and wide range of forecast adjustments imply that the current modeling techniques are struggling to capture future expectations of COVID-19 impacts.

Natural Gas. Weather normalized commercial natural gas sales decreased 2.97% in 2020. The decline is consistent with business closures and operational changes resulting from the COVID-19 response. However, the 2021 forecast growth is 3.83% and the long-term growth is 0.95%. The forecast growth rates show a return to pre-pandemic levels of sales beginning in 2021.

While this year's survey asked whether gas companies made additional changes to their 2021 commercial forecast, only 1 gas company reported making a change. This change increased commercial sales by 5.3%.

Industrial Sales Growth

Figure 10 shows past and current reported weather normalized industrial sales growth rates. Additionally, the figure shows the 2021 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average growth rate. Forecasts include respondent's expectations of COVID-19 impacts.

Figure 10: Industrial Sales Growth

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Forecast 2021	Forecast 2021-2031	Average 2015-2019
Canada	(1.57)	(1.41)	(1.06)	(1.59)	(0.27)	(0.93)	2.81	1.23	(1.18)
Midwest	(0.71)	0.41	0.20	1.29	(2.59)	(5.12)	3.21	0.71	(0.28)
Northeast	(3.44)	(1.74)	1.33	(1.15)	(2.63)	(5.96)	3.28	(0.29)	(1.53)
South	1.75	0.36	1.26	1.95	1.56	1.13	(1.11)	1.05	1.38
West	(1.47)	(1.89)	(1.97)	0.11	2.06	1.04	5.51	1.99	(0.63)
Electric Total	(0.33)	(0.23)	0.33	0.76	0.21	(1.09)	1.64	1.01	0.15
Natural Gas Total	(0.13)	4.61	2.33	(0.33)	3.23	(6.94)	7.82	(0.05)	1.94

Electric. Weather normalized electric industrial sales declined 1.09% in 2020. The decline is a result of healthcare policy orders and business closures in response to COVID-19. The forecast for 2021 shows an increase of 1.64% reflecting a full return to normal levels. The long-term growth rate of 1.01% is higher than the pre-pandemic 5-year average growth rate (0.15%) reflecting an expectation of a strong recovery over the next 10 years.

Only 12% of companies made additional changes to their 2021 forecasts to reflect continuing COVID-19 impacts. Of these changes, 45% increased their forecast and 55% decreased their forecast. The changes range between decreasing the forecast by 18.3% to increasing the forecast by 10.0% with the weighted average change being an increase of 0.40%.

Natural Gas. Natural gas companies saw average weather normal sales decrease of 6.94% in 2020. The decline is consistent with business closures and operational changes resulting from the COVID-19 response. However, the 2021 forecast growth is 7.82% with the long-term decline of 0.05%. The forecast

shows a return to pre-pandemic levels of sales beginning in 2021 with the long-term growth effectively flat. No gas respondents made additional changes to their forecast beyond normal model updates in response to COVID-19.

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 2021 forecast growth rate, the ten-year forecast growth rate, and the pre-pandemic 5-year average growth rate. Forecasts include respondent's expectations of COVID-19 impacts.

Figure 11: System Energy

Region	Actual 2015	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Actual 2020	Forecast 2021	Forecast 2021-2031	Average 2015-2019
Canada	(1.41)	(0.02)	0.21	0.26	(0.08)	(0.31)	1.33	0.91	(0.21)
Midwest	(0.34)	0.35	(0.14)	0.14	(1.22)	(2.56)	0.39	0.39	(0.24)
Northeast	(1.59)	(0.41)	0.36	0.21	(1.22)	(3.55)	(0.08)	0.62	(0.53)
South	1.54	0.35	0.42	2.56	0.11	(0.26)	0.91	0.80	0.99
West	(1.18)	0.07	0.34	0.15	0.24	(0.31)	2.19	1.37	(0.08)
Electric Total	(0.12)	0.21	0.26	1.24	(0.25)	(1.14)	0.86	0.68	0.27
Itron WN	(0.17)	(0.22)	0.48	1.07	(0.51)	(2.53)			0.13
Natural Gas Total	1.50	1.48	1.54	(0.56)	2.82	(1.79)	2.71	0.66	1.36

Electric. Weather normalized system energy declined 1.14% in 2020. The decline is a result of large downward impacts on the commercial and industrial class resulting from the healthcare policy orders and business closures in response to COVID-19 relative to the gains in the residential class. The 2021 forecast growth is 0.86% and implies a partial recovery from the 2020 decline. The long-term forecast growth (0.68%) is much higher than the pre-pandemic 5-year growth rate (0.27%) and implies a return to pre-pandemic forecast levels within the decade.

For comparative purposes, Itron weather normalizes United States sales based on EIA data. Itron's weather normalized sales are preliminary because the EIA updates its data at the end of the year. In 2020, Itron shows a weather normalized decline of 2.53%.

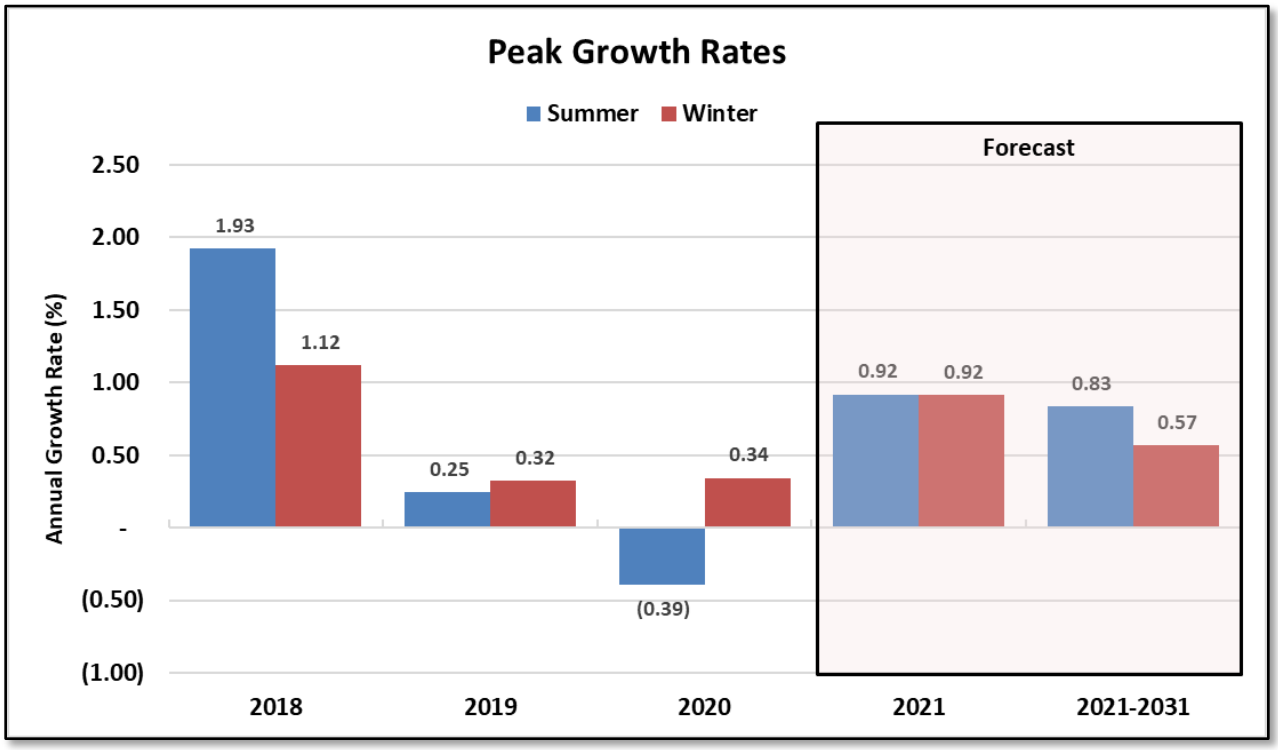
28% of companies changed their system forecast beyond the normal model updates (i.e., updated economics and historical data) in response to COVID-19. Of these respondents, 31% increased their forecast and 69% decreased their forecast. The changes range between decreasing the forecast by 6.20% to increasing the forecast by 6.70% with the weighted average change being a decrease of 0.69%.

Natural Gas. Weather normalized natural gas system sales decreased 1.79% in 2020. The decrease is driven by declines in the commercial and industrial classes. The 2021 forecast growth rate is 2.71% reversing the 2020 decline. The long-term forecast growth expectation is 0.66% which is consistent with the pre-pandemic 5-year average growth rate (0.70%).

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 averages are not available for historical peak because the Itron did not ask for summer and winter peak information prior to 2018. Forecasts include respondent's expectations of COVID-19 impacts.

Figure 12: Electric Peak Growth



Summer peaks declined 0.39% in 2020. The decline reflects the offsetting responses of the residential, commercial and industrial classes to COVID-19. Summer peaks are expected to grow 0.92% in 2021 with the long-term growth rate of 0.83%. The 2020 decline followed by the forecast increases show that companies do not expect that COVID-19 will have a sustained impact on summer peaks.

Winter peaks grew 0.34% in 2020. This growth is like 2019 and suggests that COVID-19 did not impact the winter peaks. The forecast winter peak growth is 0.92% in 2021 and 0.57% in the long-term.

13% of companies changed their system peak forecast beyond the normal model updates (i.e., updated economics and historical data) in response to COVID-19. All of these respondents are summer peaking companies with 75% of them increasing their forecast and 25% decreasing their forecast. The changes range between decreasing the forecast by 1.20% to increasing the forecast by 3.30% with the weighted average change being an increase of 1.15%.

COVID Impacts

While the 2020 COVID impacts vary by utility, the overall effect is an increase in residential sales and decrease in commercial, industrial and system sales. Because the COVID healthcare policy orders began in March 2020, summer peaks are lower than expected. However, winter peaks are generally unaffected since the 2020 winter peaks either occurred before March or after healthcare policy orders were eased.

This year's survey seeks to understand the COVID-19 impacts and the utility perceptions about the permanence of these impacts.

Estimated 2020 COVID Growth Rate Impacts. The COVID-19 sales impact is measured using two methods. First, the impact is calculated by comparing the actual growth rates with expected growth rates based on the pre-pandemic 5-year averages. Second, the impact is calculated by comparing the actual growth rates with the pre-covid forecasting growth rates. The difference between these growth rates is the estimated covid impacts and are shown in Figure 13.

Figure 13: COVID-19 Electric and Natural Gas Sales Growth Rate Impact

	Actual 2020	Est. Covid Impact vs Avg Growth	Avg Growth 2015-2019	2020 Pre-Covid Forecast	Est. Covid Impact vs. Fcst Growth
Electric					
Residential	3.80	3.53	0.27	0.89	2.91
Commercial	(4.95)	(5.31)	0.35	0.19	(5.15)
Industrial	(1.09)	(1.24)	0.15	2.57	(3.67)
System	(1.14)	(1.41)	0.27	1.00	(2.13)
Summer Peak	(0.39)	(1.29)	0.90	(0.31)	(0.08)
Winter Peak	0.34	NA	NA	0.97	(0.62)
Natural Gas					
Residential	1.15	0.97	0.19	0.04	1.12
Commercial	(2.97)	(4.00)	1.04	0.25	(3.21)
Industrial	(6.94)	(8.88)	1.94	0.46	(7.39)
System	(1.79)	(3.15)	1.36	0.14	(1.92)

As seen in the figure, the COVID-19 impact appears to have increased electric residential sales 2.91% compared with the pre-covid forecasts and 3.53% compared with the 5-year average growth. Likewise, the natural gas residential sales impact was between 0.97% and 1.12% depending on the comparison. Sales declines for the commercial, industrial and system range between 1.24% and 8.88% for both the electric and natural gas classes.

Weather Response Changes. A system's weather response is the relationship between weather and energy consumption by heating and cooling systems. Typically, rising temperatures in the summer result in increasing air conditioning usage which increases electric consumption. Likewise, lowering temperatures in the winter increase heating equipment usage which increases energy consumption. These relationships are known as the weather response and are expressed as the energy change per degree (e.g., kWh/degree or MMBtu/degree).

Figure 14 shows the survey responses to about changes in the strength of weather responses due to COVID-19. As shown, 26% indicate that their summer weather response increased and 18% indicate that their winter response increased. Increases are attributed to heating and cooling system usage changes due to more people working from home. For both summer and winter response changes, 5% indicate decreases in the summer and winter weather response. Decreases are attributed to lower commercial building occupancy resulting in lower needs for heating and cooling.

Figure 14: Did COVID-19 Change the Weather Response?

	Yes Increase	Yes Decrease	No	Don't Know
Summer Weather Response	26%	5%	40%	28%
Winter Weather Response	18%	5%	48%	28%

Identification of weather response changes is a challenging modeling problem and requires modeling weather response before and during the pandemic. Often changes are subtle and difficult to separate from baseload changes and economic impacts. Estimation of these changes is enabled by higher frequency data (such as daily AMI data). and requiring AMI data. The large precentage of responses in the "No" and "Don't Know" categories may indicate that these subtle changes are difficult to detect with monthly data.

Forward-Looking Expectations. While respondents can understand the sales and weather response changes based on analysis of 2020 (and partial 2021) data, decisions about extending these changes into the future is a major challenge for forecasting. Figure 15 shows the forward-looking responses from survey participants.

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

	Yes	No	Don't Know
Do you adjust your 2022 forecast for COVID	53%	47%	
Do you think COVID has permanently impacted your system energy demand?	32%	40%	28%

First, 53% of forecasters made external adjustments to their 2022 sales forecast. These changes may occur in a single class (e.g., residential) or in multiple classes. These changes are in addition to the regular process of updating data, model variables, and economic forecasts during the modeling process. The large number of changes highlight the modeling challenge facing forecasters. While the modeling process naturally captures the changes in the economy based on traditional economic indicators such as employment or GDP, the models struggle to capture the variability associated with healthcare policy orders and its potential energy response. When models cannot adequately capture the COVID-19 effect, utility forecasters will manually adjust their forecast based on their expectations.

Second, while Itron has proposed several methods for modeling the COVID-19 impact, all modeling solutions require an expectation about how long the COVID-19 impacts will last. Figure 15 shows that 32% of respondents believe that COVID-19 will have permanent impacts on energy demand and 40% believe that the impact is temporary. If the impact is permanent, modeling changes (i.e., new variables) are needed to adjust the forecasts for this lasting impact. If the impact is temporary, simple changes such as external adjustments or removing the COVID-19 data may be used to until the COVID-19 impact is gone.

Electric Forecast Accuracy

Three types of errors are reported in the survey. First, companies are asked to compare their 2020 forecast (generated in 2019) against weather normalized 2020 sales. Second, companies are asked to compare the same forecast and against actual 2020 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 16 and Figure 17. The figures show the 2021 MAPE, the average annual MAPEs from the 2015 through 2021, and the variance associated with the annual average MAPEs from?? 2015 through 2021. Figure 16 shows the annual forecast errors compared against weather normalized actual values. Figure 17 shows the annual forecast error compared against actual values. All MAPE values are unweighted.

Figure 16: Annual Electric MAPE - Forecast Versus Weather Normal Actuals

Class	2021 Survey	2015-2021 Mean	2015-2021 Variance
Residential	3.78	1.88	0.76
Commerical	6.53	2.30	3.54
Industrial	8.32	3.75	4.57
System	3.13	1.66	0.49
Peak	2.76	2.59	0.10

Figure 17: Annual Electric MAPE - Forecast Versus Actuals

Class	2021 Survey	2015-2021 Mean	2015-2021 Variance
Residential	3.53	2.70	0.75
Commerical	6.83	2.38	3.91
Industrial	8.12	3.78	4.16
System	3.65	1.89	0.69
Peak	4.88	2.13	0.73

As expected, COVID-19 impacts significantly increased forecast errors. Forecasts for 2020 generated in 2019 did not foresee the sweeping healthcare policy orders, business closures, and shifting of work locations. As a result, the 2021 errors are not typical of industry standards and indicate the additional uncertainty that can materialize from an unexpected global pandemic.

Likewise, next year's survey (in 2022) will likely result in high errors due to the inability to predict the duration of healthcare policy orders, the public's response to the orders, the rise of new COVID-19 variants, and the energy impacts of new economic stimulus actions.

Monthly Forecast Accuracy. Figure 18 shows the monthly average errors by class with comparative values from prior years' surveys. As expected, monthly errors are higher than prior year errors due to COVID-19. Additionally, monthly errors are higher than annual errors because monthly errors can offset each other when the annual sum is computed.

Figure 18: Monthly Average Electric Error Results (Unweighted)

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

Natural Gas Forecast Accuracy

As with the electricity sector, natural gas companies are also asked to compare their forecast for 2020 (generated in 2019) against actual and weather normalized sales in 2020. Figure 19 and Figure 20 show the companies' unweighted annual MAPEs. The figures also show the annual MAPE, the average annual MAPEs from the 2015 through 2021, and the variance associated with the annual average MAPEs from 2015 through 2021. Figure 21 shows the unweighted monthly MAPEs.

Annual Forecast Accuracy. Figure 19 and Figure 20 shows that all class forecasting errors are close to the historical survey means. This result is surprising considering the lack of COVID-19 information at the time of the forecast. However, the largest COVID-19 impacts occurred with the initial economic shutdown beginning in late March 2020 and extending through the summer. The timing of the healthcare policy orders misses the majority of the winter heating season. First, the January through March heating period is unaffected by COVID because it is before the orders. Second, the November and December heating period is after many orders were lifted. As a result of this timing, the forecast errors have not been significantly impacted.

Figure 19: Annual Natural Gas MAPE - Forecast Versus Weather Normal Actuals

Class	2021 Survey	2015-2021 Mean	2015-2021 Variance
Residential	2.01	2.72	0.48
Commerical	4.78	4.12	0.99
Industrial	6.58	7.51	11.55
System	2.42	3.83	1.68

Figure 20: Annual Natural Gas MAPE - Forecast Versus Actuals

Class	2021 Survey	2015-2021 Mean	2015-2021 Variance
Residential	3.52	8.33	15.69
Commerical	7.60	6.83	5.78
Industrial	8.39	8.46	11.51
System	4.74	7.23	4.95

Monthly Forecast Accuracy. Monthly forecast accuracy is considerably worse (higher MAPE values) than annual accuracy, because variations in one month can offset variations in other months when aggregated to the annual totals. The monthly MAPEs are shown in Figure 21.

Figure 21: Monthly Average Gas Error Results (Unweighted)

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

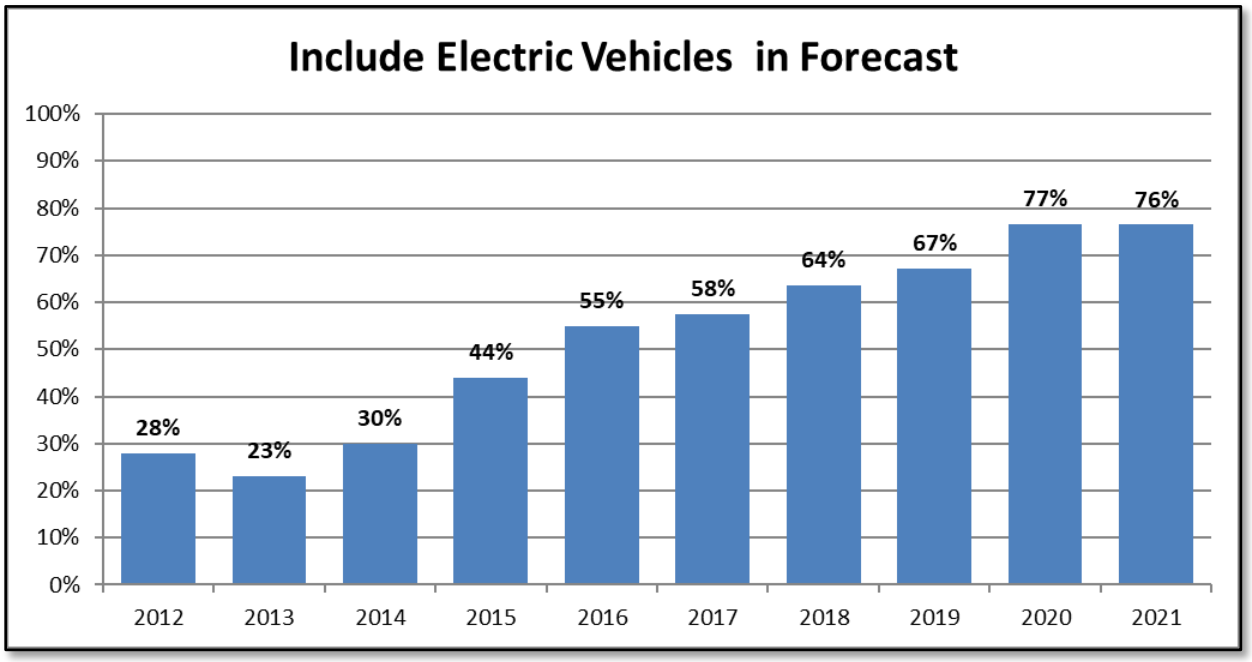
Key Forecast Characteristics

As part of the annual survey, Itron tracks changes in forecasting practices. This year, these changes include accounting for new technologies and forecast methods.

Electric Vehicles

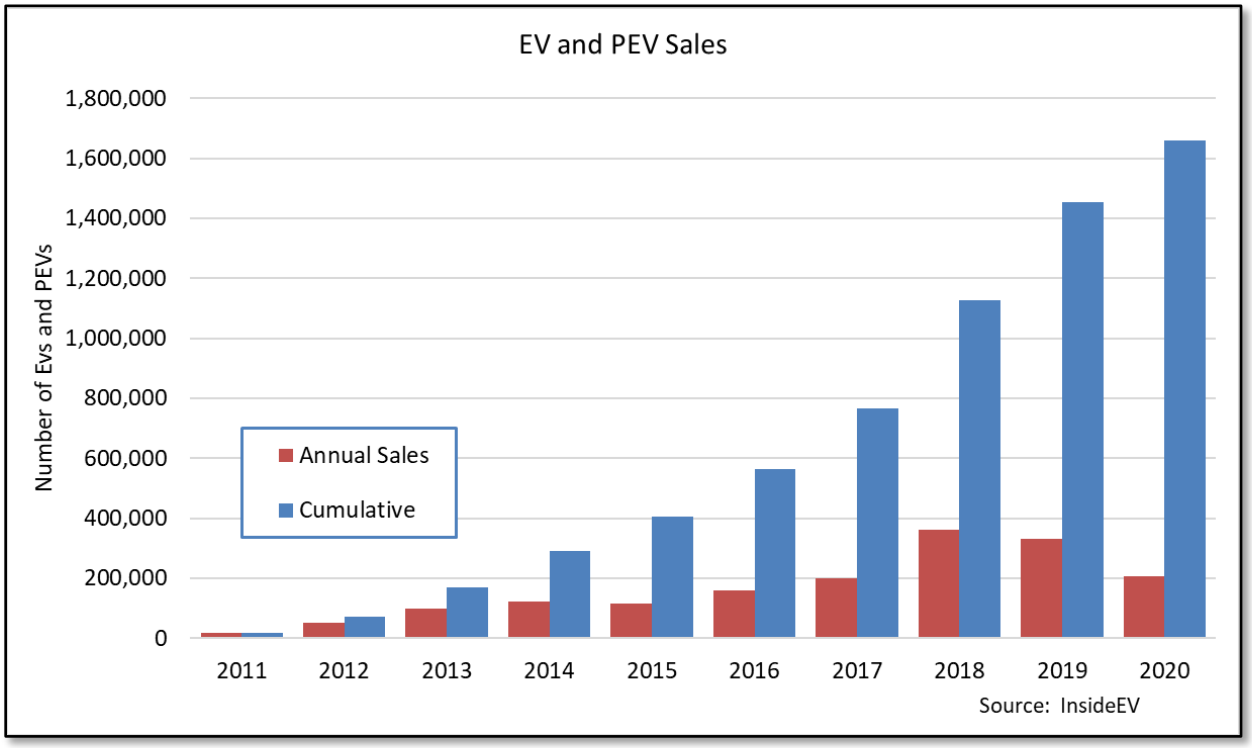
Figure 22 shows the percentage of companies who explicitly include electric vehicles (EVs) in their forecast. This year, 76% reported included EVs, which is similar to the result from the prior survey.

Figure 22: Include Electric Vehicles in the Forecast



In 2020, EV sales slowed largely due to the pandemic. However, EVs continue to show growth and are a key component in reducing CO2 emissions. With every major auto manufacturer committing to adding EVs to their model lines, this technology is poised to show significant growth in the coming years and should be recognized in electric forecasts. Figure 23 shows cumulative number of EV and plug-in EV sales, compiled from *InsideEV* data reports.

Figure 23: Historic EV and PEV Sales



Photovoltaics.

Figure 24 shows the share of companies that include photovoltaics (PV) in their forecast. This year, 71% of respondents reported inclusion of PV forecasts in their process. Since 2018, over 70% of companies forecast PVs, making its inclusion a standard practice among utilities.

Figure 24: Include Photovoltaics in the Forecast

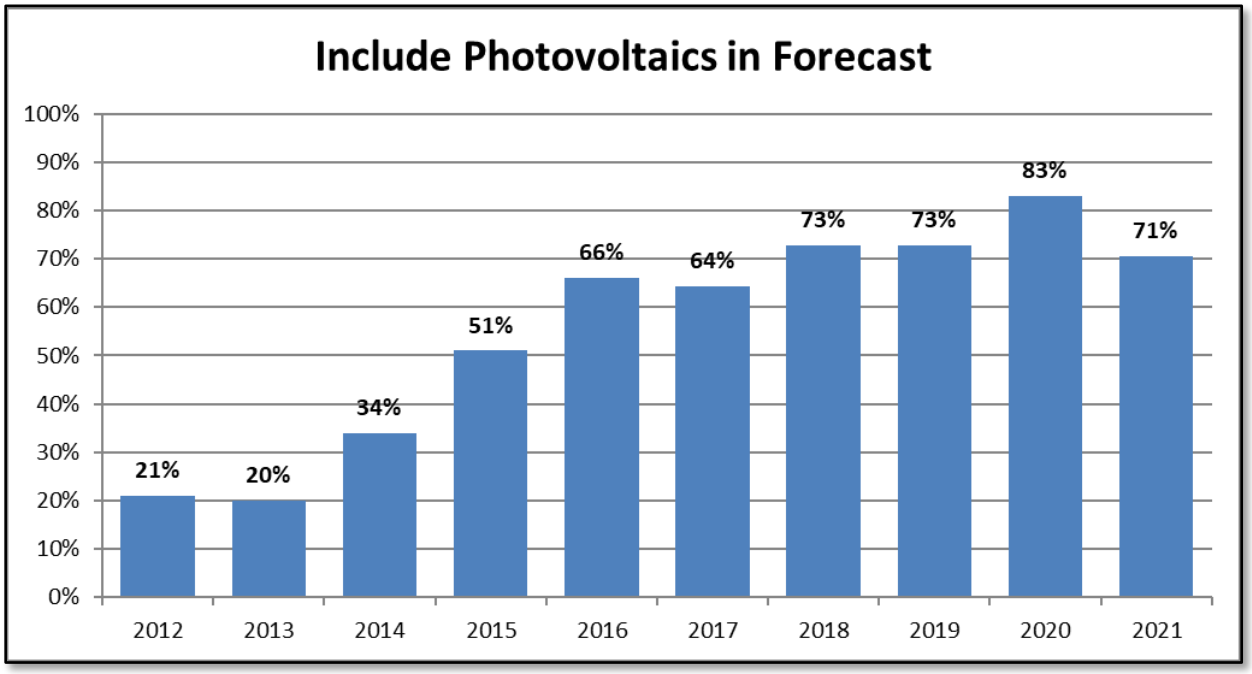
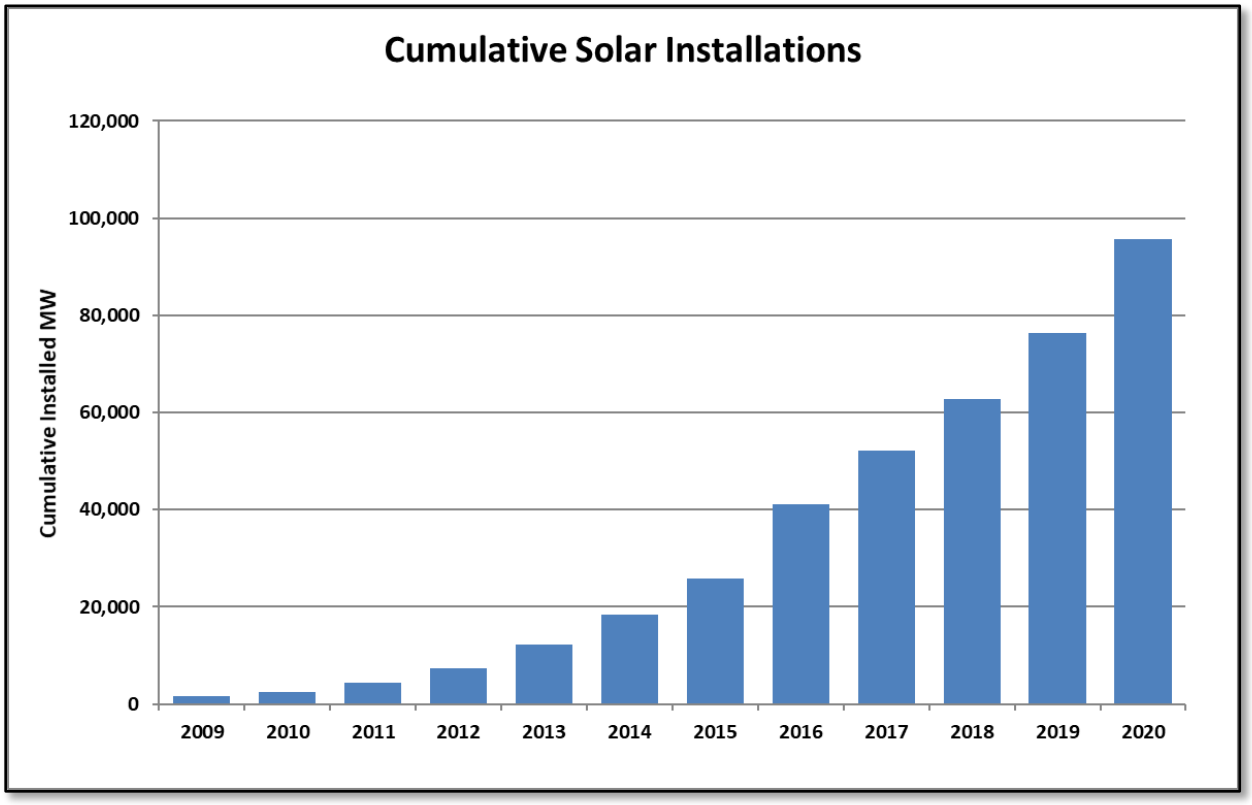


Figure 25 shows the cumulative growth in installed solar capacity across the United States based on data complied by Itron through various sources. PV installations continue to gain traction with a 25% increase in installations in 2020.

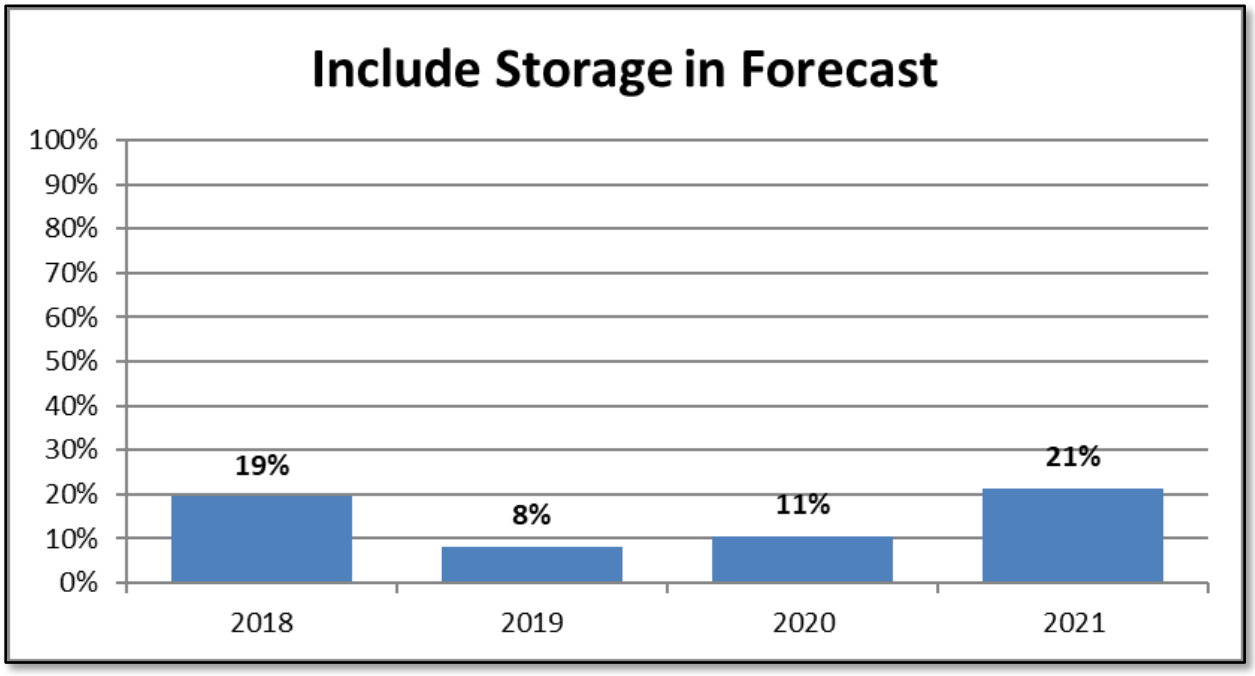
Figure 25: Solar Installations



Electric 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 watch the market to identify signs and factors that will assist them in forecasting this technology. Figure 26 shows only 21% of companies are including storage in their forecasts. The percentage has not significantly changed since the survey began asking this question in 2018.

Figure 26: Include Battery/Storage in the Forecast



Sales Forecast Modeling.

Two forecasting methods dominate long-term residential and commercial sales forecasting process. These methods are (1) forecasting sales with one model and (2) forecasting sales using two models. The One Model method uses a regression model with the Y-variable defined as the sales (kWh). The Two Model method uses a customer count model and an average use model with sales calculated as the product of the two model results. In the Two Model method, the average use model (i.e., use-per-customer) is a regression model with the Y-variable defined as sales divided by customers or use-per-customer. Figure 27 shows the percentage of companies using these methods.

Figure 27: Sales Forecasting Method

Method	Residential	Commercial
One Model: Sales Directly	11%	60%
Two Model: Customers and Average Use	86%	35%
Other	3%	5%

The residential class is dominated by the Two Model method. The advantage of this method is the separation of economic variables. In the customer model, economic drivers describe the factors creating customer formation. These economic drivers tend to be macroeconomic variables such as population and households. In the average use model, economic variables describe how electricity is used. These economic drivers include variables such as end-use technology saturation and efficiency, weather,

average household size, household income, and energy prices. Separating the sales forecast into two models avoids multicollinearity problems and increases the descriptive power of the model.

The commercial sector is dominated by the One Model method. While the advantages of the Two Model method still apply to the commercial sector, the lack of homogeneity among commercial customers makes describing commercial average use more difficult than describing residential average use. When average usage cannot be adequately modelled, the One Model method simplifies the forecasting process while still producing strong results.

Peak Forecast Modeling

In 2015, Itron conducted a peak forecasting survey to understand the methods used to forecast system peaks. Based on the 2015 survey, Itron identified three general approaches to peak forecasting. These approaches are defined below.

Regression Approach. The Regression Approach develops the peak forecast with an econometric model using historical peaks as the dependent variable. The generalized model is shown below.

Peak = f (Weather, Calendar Conditions, End-Use Information, Trends, …)

This approach relies on correlating historical peaks with variables that explain and predict future peaks. Typically, the explanatory variables include weather conditions and growth drivers.

Load Factor Approach. The Load Factor Approach develops the peak forecast based on an energy forecast and load factor prediction. Load factors are obtained by using an econometric model or alternative technique (e.g., historic average or trend). Once the load factor is forecast, the peaks are derived by applying the load factor to the energy forecast. In this approach, changes in peaks are driven by energy growth and load factor changes.

Bottom-Up Approach. The Bottom-Up Approach develops the peak forecast by summing hourly load profiles. Load profiles may be developed at any level (e.g., revenue class level or end-use level). The profiles are scaled to energy, adjusted for losses, and summed to predict the system total. The highest hourly value in a year or month is the peak forecast. The Bottom-Up approach allows companies to capture changing peak hours based on the composition of the underlying load shapes.

This year's survey updates the 2015 survey to understand how company peak forecasting approaches have changed. Figure 28 shows the percentage of companies using the different approaches and compares the result with the 2015 survey results.

Figure 28: Peak Forecasting Method

Method	2021 Survey	2015 Survey
Regression	64%	74%
Load Factor	11%	16%
Bottom-Up	21%	10%
Other	4%	NA

The Regression approach continues to be the dominant approach to peak forecasting. However, the number of companies using the Bottom-Up approach increased from 10% in 2015 to 21% in 2021. The primary advantage of a Bottom-Up approach compared with a Regression approach is the ability to model load shape diversity and peak hour changes. The increasing penetration of behind-the-meter solar and potential scenarios created by electric vehicles and energy storage may change the system peak hour which is easiest to model using hourly load shapes.

Conclusion

This year's survey focuses on COVID-19 impacts on 2020 sales and expected growth. In 2020, electric sales decreased by 1.14%, reversing the positive historical growth trend of 0.27% per year. Likewise, natural gas sales decreased 1.79% compared to the positive historical growth trend of 0.36%. In 2020, both electric and natural gas companies show higher than expected residential sales which is offset by much lower commercial and industrial sales.

Relative to previous expectations, COVID-19 impacts increased 2020 electric sales by 2.91% to 3.53%, lowered commercial sales by 5.15% to 5.31%, and lowered industrial electric sales by 1.24% to 3.67%. Similarly, residential natural gas sales impact increased residential sales growth by .04% to 0.97%, lowered commercial sales growth by 3.21% to 4.00%, and lowered industrial sales growth by 7.39% to 8.88%.

COVID-19 impacts are expected to be relatively short lived. According to survey respondents, both electric and natural gas sales are expected to bounce back with strong growth from 2020 to 2021, although sales will not return to pre-pandemic forecast levels until after 2021 due to lingering effects.