AUSTIN ENERGY'S	§	**BEFORE THE CITY OF AUSTIN**
2022 BASE RATE REVIEW	§	
	§	**IMPARTIAL HEARING EXAMINER**

AUSTIN ENERGY'S RESPONSES TO QUESTIONS RELATED TO TECHNICAL CONFERENCE #2

Austin Energy held a Technical Conference on Wednesday, May 18, 2022, to allow Participants to ask questions related to the 2022 Austin Energy Base Rate Review. During the discussions at the Technical Conference, Austin Energy committed to answering certain questions in more detail. The purpose of this filing is to follow up regarding those questions and provide the responses to the public to allow for increased ease and access to information for all Participants.

Respectfully submitted,

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ATTORNEYS FOR THE CITY OF AUSTIN D/B/A AUSTIN ENERGY

Austin Energy's Responses to Questions from the Independent Consumer Advocate (ICA)

ICA TC 2-3: How many residential customers were subject to outage during Winter Storm Uri? What was the average duration of the outage? How many small commercial and large commercial customers were subject to outage during Winter Storm Uri? What was the average duration of the outage?

ANSWER: While some of these questions were addressed during the Technical Conference, the rest are available via the resources described and provided below.

Austin Energy's After Action Report and Quarterly Status updates are available on Austin Energy's website:

https://austinenergy.com/ae/about/reports-and-data-library/corporate-reports

The "Austin Energy February Winter Storms After-Action Report" can be located here:

https://austinenergy.com/wcm/connect/482f26ba-7c94-465a-8a00-59bd65f33967/Feb2021-WinterStormsAfterActionReport.pdf?MOD=AJPERES&CVID=nS28hAN

ICA TC 2-4:	Provide gross plant and accumulated depreciation for Austin's share of Fayette Power Plant.
ANSWER:	As of FYE 2021, Austin Energy's book value of Fayette Power Plant is \$533.2 million with accumulated depreciation of \$403.5 million.

ICA TC 2-5: Provide AE's standing in the J.D. Powers customer satisfaction index for residential and commercial customers.

ANSWER: Our 2021 Customer Satisfaction Index (CSI) for Residential customers is 716 and for Commercial customers is 754, compared to when we began tracking CSI for both in 2016, at which time our Residential CSI was 673 and Commercial CSI was 669.

ICA TC 2-8: What is the price elasticity of demand for residential customers used in the weather model? For AE planning purposes, what is the long run price elasticity of demand for residential consumption.

ANSWER: Please refer to the discussion from Austin Energy's Technical Conference #2. The video recording of Technical Conference #2 may be found at: https://austintx.new.swagit.com/videos/174228

The following attachments were shown on screen:

Attachment ICA TC 2-8a
Attachment ICA TC 2-8b
Attachment ICA TC 2-8c

Residential Statistically Adjusted End-Use (SAE) Spreadsheets – 2021 AEO Update

The Residential SAE spreadsheets and models have recently been updated to reflect the Energy Information Administration's (EIA) 2021 Annual Energy Outlook (AEO).

This EIA release is based on the 2015 Residential Energy Consumption Survey (RECS). The EIA forecast is an end-use based projection where 2015 is the "first" forecast year. The model starts with reported 2015 saturation rates and estimated stock efficiency. Saturation and stock estimates move forward from this point based on assumptions of relative technology efficiency, new appliance purchases, appliance costs (including rebates for utility efficiency programs), electricity prices, weather trends, and stock utilization. Results are calibrated into actual customer usage and the EIA short-term energy forecast.

The 2021 residential SAE spreadsheets and MetrixND project files include:

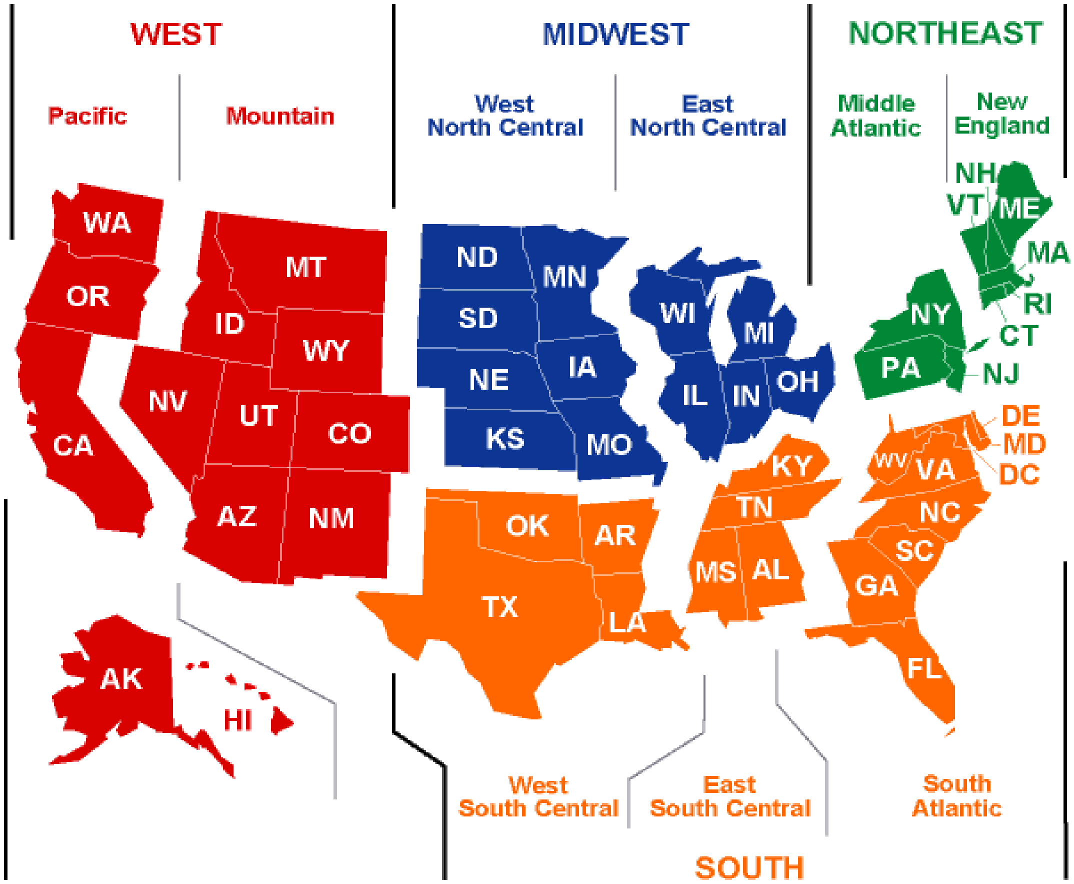
- Updated equipment efficiency trends
- Updated equipment and appliance saturation trends
- Updated structural indices
- Updated annual heating, cooling, water heating, and non-HVAC indices
- Updated regional sales forecasts

End-use saturation, efficiency, structural changes (building shell efficiency improvements and square footage projections), and base-year end-use energy use are combined to develop historical and projected end-use intensity estimates. Resulting intensities can be used in constructing heating, cooling, and other use variables for residential average use and total sales forecast models.

End-use saturation, efficiency, and average annual appliance use (UEC – Unit Energy Consumption) are derived from the National End-Use Model System (NEMS). While NEMS generates detailed end-use data, EIA is primarily concerned with the high-level projection of total energy requirements (measured in Btu) across all end-uses and sectors including transportation. From an electric or natural gas utility forecaster's perspective, it is the underlying end-use and technology level detail that provides insights into how individual residential and commercial customers are using electricity and natural gas, trends in end-use energy consumption, and what these trends imply for future electric and gas usage at the regional level.

EIA provides end-use detail for nine census divisions, depicted in Figure 1.

Figure 1: Forecast Census Divisions



The 2021 AEO forecast is based on the 2015 Residential Energy Consumption Survey (RECS). Base-year UECs, saturations, and stock efficiencies are derived from reported results. The NEMS model tracks end-use saturation, stock efficiency, and usage change over time as appliances are replaced, new appliances are purchased, and utilization changes with changing economic, price, and weather conditions. Appliance choice decisions are driven by appliance costs, efficiency options and standards, natural gas availability, and fuel prices for electricity and natural gas. Forecasts are developed for three housing types – single family, multi-family and mobile homes, for twenty end-uses, including:

- Resistance heating/furnaces
- Air-source heat pumps (heating)
- Ground-source heat pumps (heating)
- Secondary heating
- Central air conditioning
- Air-source heat pumps (cooling)
- Ground-source heat pumps (cooling)
- Room air conditioning
- Water heating
- Cooking

- 1st refrigerators
- 2nd refrigerators
- Freezers
- Dishwashers
- Clothes washers
- Clothes dryers
- TVs and related equipment
- Furnace fans
- Lighting
- Miscellaneous

In the Statistically Adjusted End-Use (SAE) model, detailed end-use data derived from the EIA forecasts is used to construct end-use intensities (kWh per household) that are then integrated into monthly heating, cooling, and other use model variables. These variables are then used to forecast utility-level residential and commercial sales through estimated linear regression models. Through the constructed model variables, forecast captures improvements in end-use efficiency driven by new standards, declining cost of high efficiency technology options, and availability of new end-use technologies.

To support econometric modeling, Itron maintains and updates historical end-use data trends that are consistent with the 2015 RECS and earlier RECS (i.e., the 2005 and 2009 RECS). Doing so sometimes requires adjusting historical end-use saturation and efficiency trends to reflect what EIA believes is the current state of appliance ownership, stock efficiency, and housing characteristics. The 2021 SAE spreadsheets reflect Itron's best estimates of historical end-use saturations, efficiency, and usage given EIA's 2015 base-year starting point and past estimates of end-use stock characteristics.

Electricity

EIA projects relatively flat total residential energy intensity (kWh per household) until well after 2030. After 2030, energy intensity turns positive largely as a result no additional end-use standards. Figure 2 shows U.S. total and base-use (excluding heating and cooling) energy intensity projections. Figure 3 shows U.S. heating and cooling intensities.

Figure 2: U.S. Residential Total and Base-Use Energy Intensities

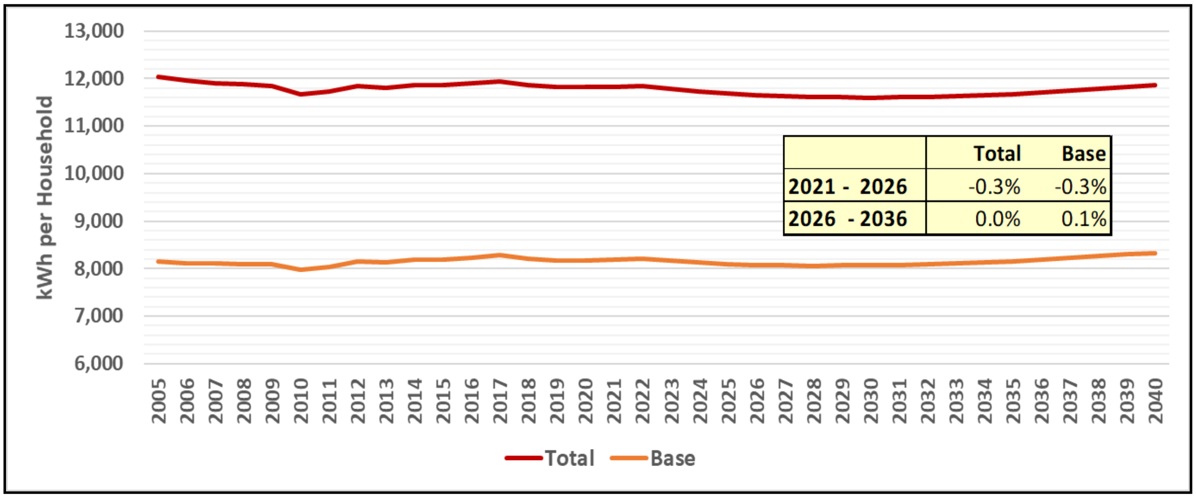
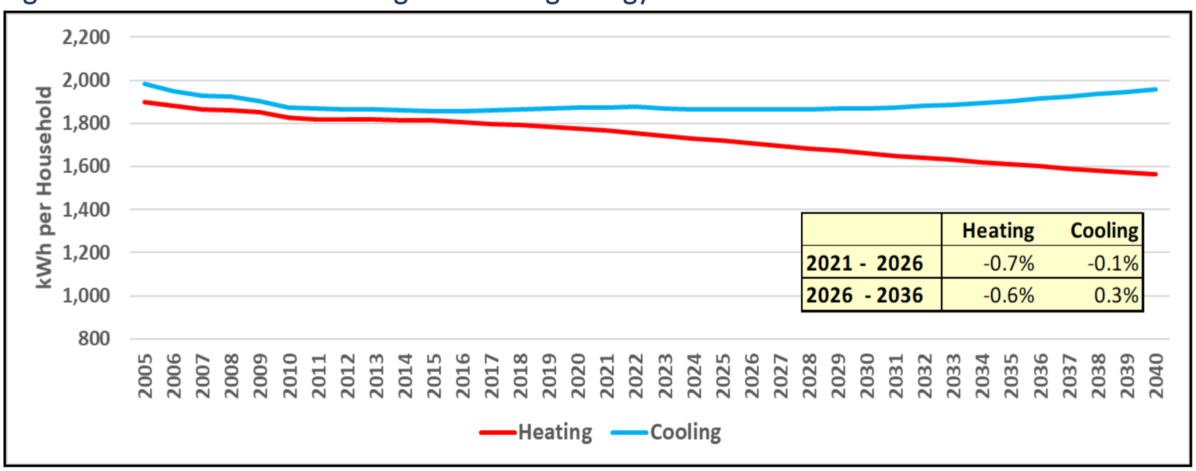


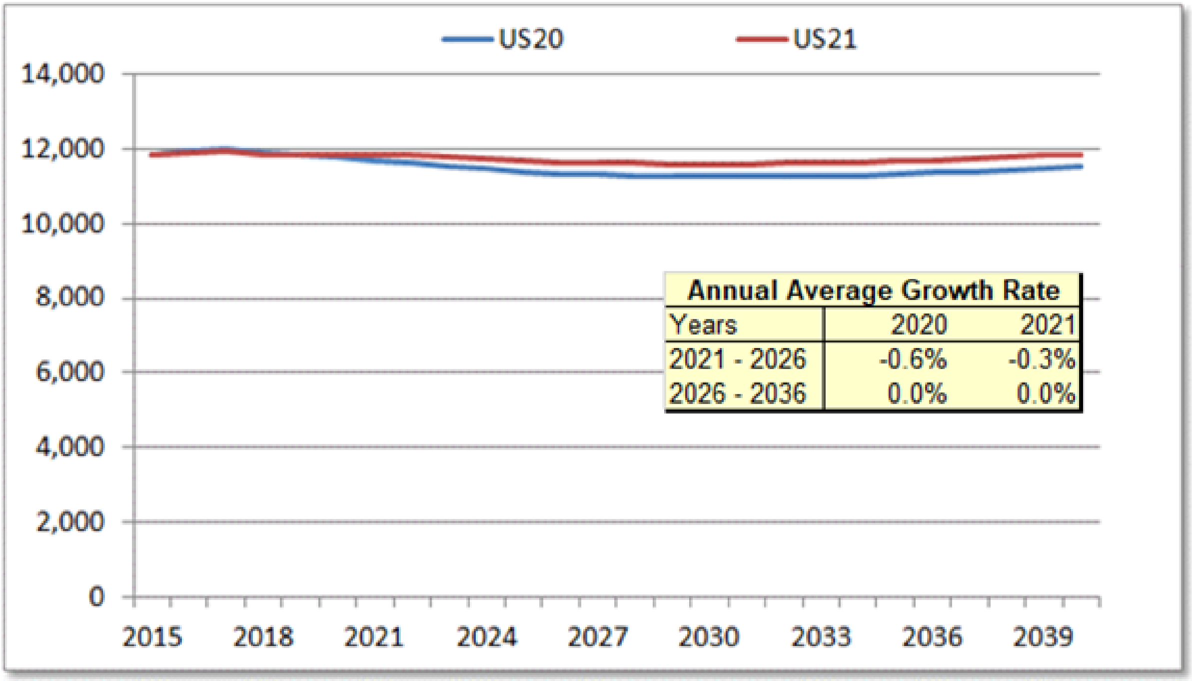
Figure 3: U.S. Residential Heating and Cooling Energy Intensities



Heating intensities, continue long-term downward trend as natural gas continues to gain market share and more efficient heat pumps gain share over resistant heat. Flat real electricity prices and improvements in furnace fan efficiency also contribute to declining heating intensity. Cooling intensities show small growth after 2027 as increasing cooling saturation is slightly stronger than efficiency improvements.

Error! Reference source not found. compares the U.S. SAE 2020 and SAE 2021 residential total household intensity projections.

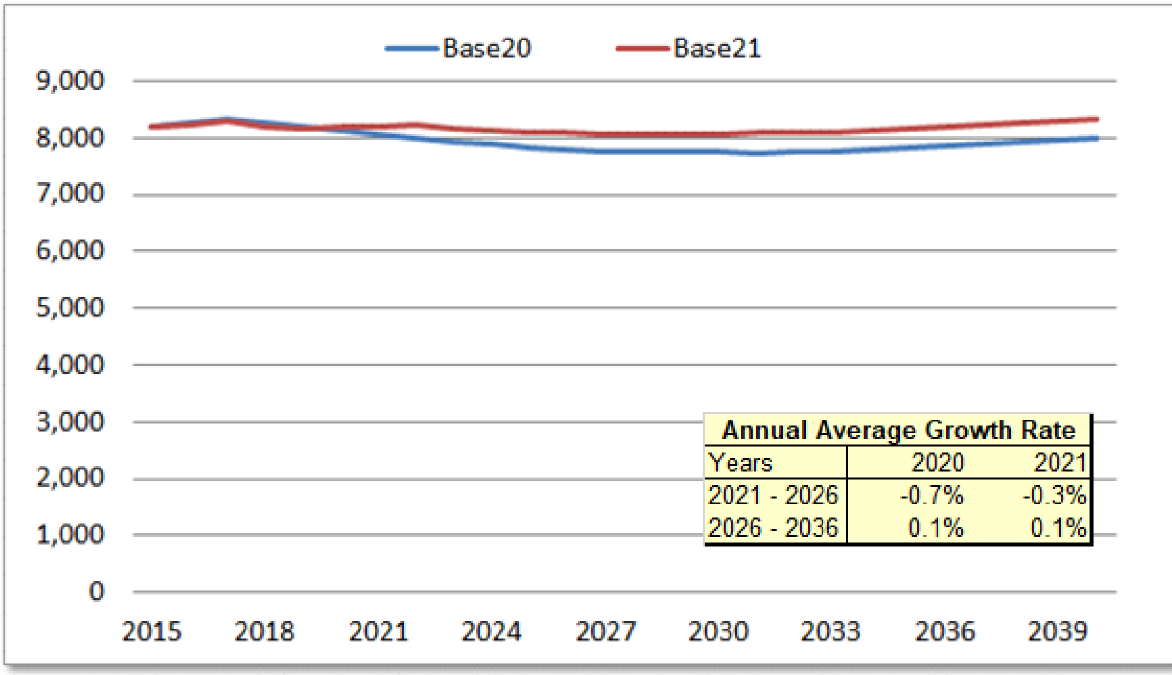
Figure 4: U.S. Heating Intensity Projections (kWh/household)



Annual Average Growth Rate		
Years	2020	2021
2021 - 2026	-0.6%	-0.3%
2026 - 2036	0.0%	0.0%

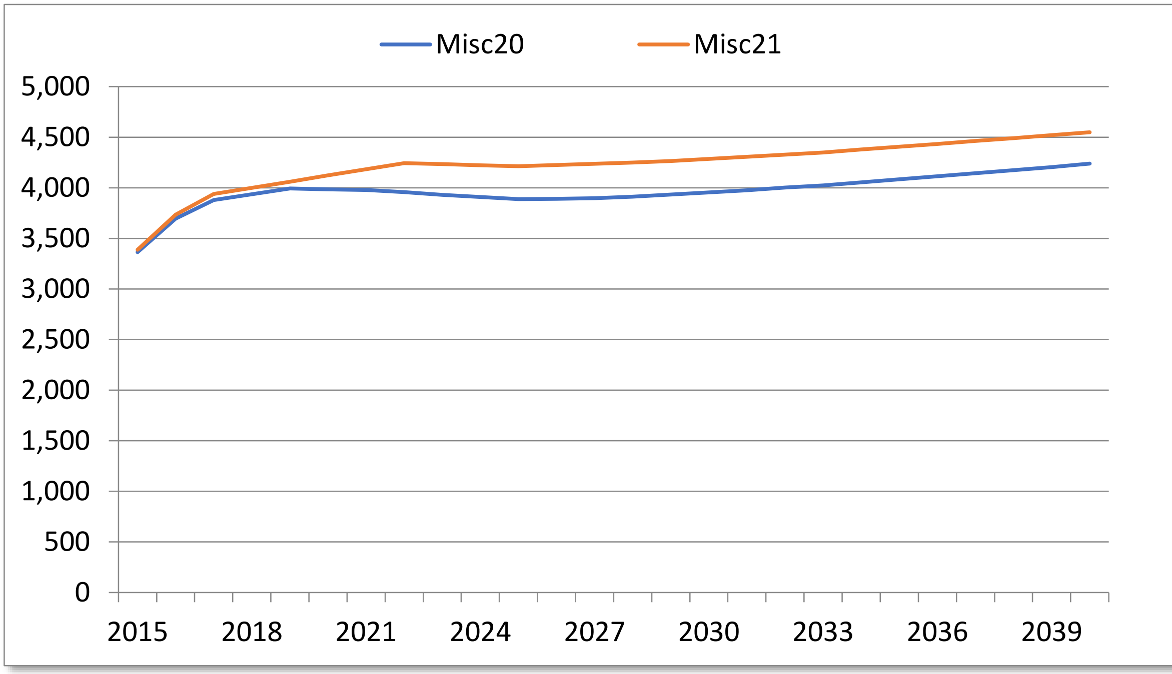
Total 2021 intensity is slightly higher than the 2020 forecast with the energy intensity declining at half the rate of the 2020 forecast through 2026. There is virtually no change in cooling and heating intensity. The difference lies in the base-use intensity as depicted in **Error! Reference source not found.**.

Figure 5: U.S. Base-Use Intensity (kWh/household)



Base-use loads (non-weather sensitive use) account for approximately 70% of residential sales. For most base end uses there is little to no difference between projected trends. The primary difference is the miscellaneous end use. **Figure 1** compares miscellaneous end use intensity projections.

Figure 1: U.S. Miscellaneous End-Use Intensity (kWh per Household)

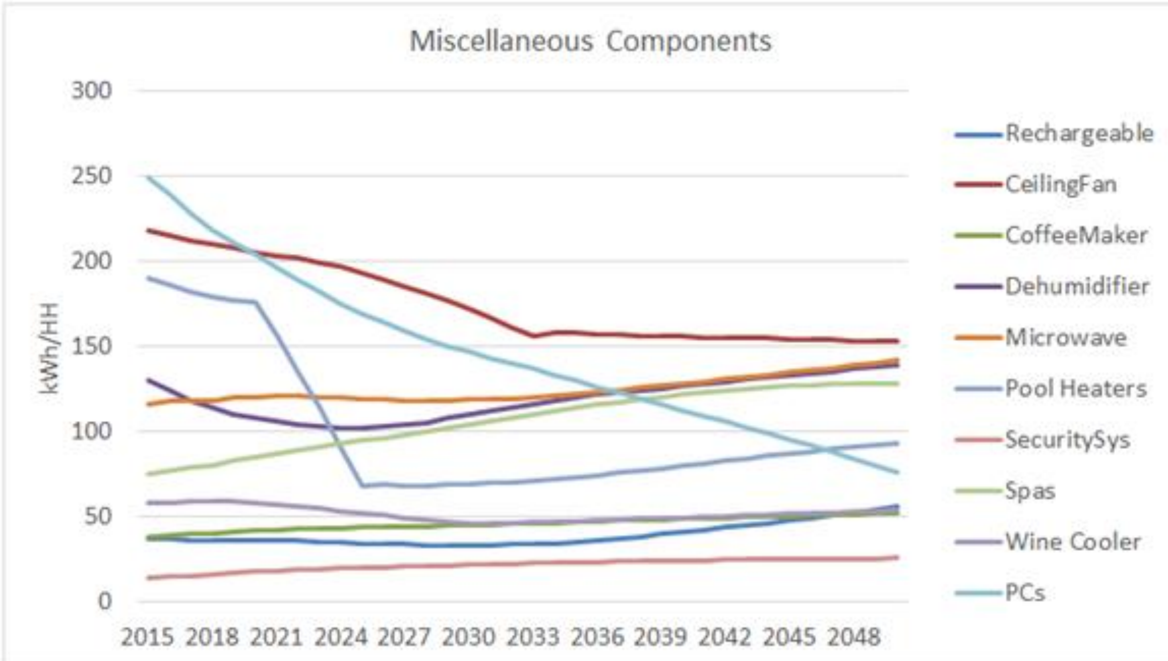


Where 2020 miscellaneous intensity declined 0.4% per year through 2026, the 2021 miscellaneous intensity increases 0.2% per year. Miscellaneous is the only end use showing positive intensity growth, and nearly all this growth is from the Electric Other classification. Specific miscellaneous end uses (Misc_Named) include:

- Rechargeable equipment
- Ceiling fans
- Coffee makers
- Dehumidifiers
- Microwave ovens
- Pool heaters
- Security systems
- Spas
- Wine coolers
- Personal computers and their related peripherals

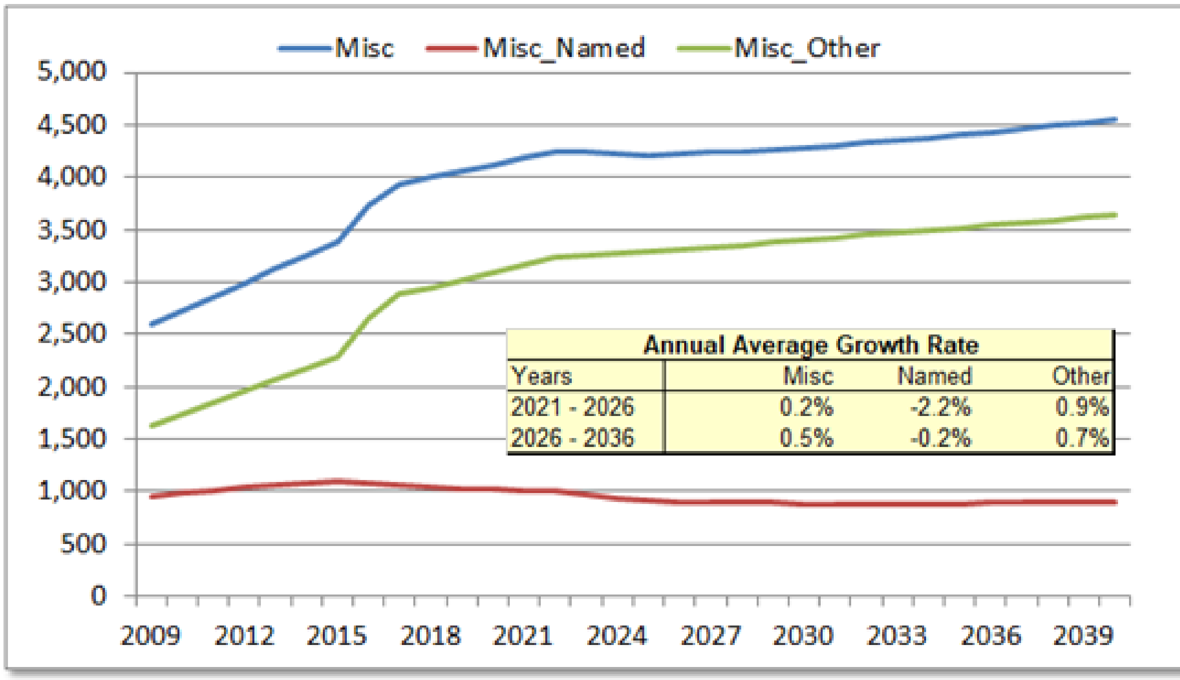
Figure 7 shows intensity projections for these end-uses:

Figure 7: Named Miscellaneous End Uses



The rest of miscellaneous use is classified as Electric Other. This would include plug loads not associated with a specific end use, including electric yard end uses such as lawn mowers, weed trimmers and leaf blowers plus other non-classified household electricity appliances. Depending on the Census Division, Electric Other accounts for two-thirds to three-quarters of Miscellaneous use and is the only end use showing relatively strong intensity growth. Figure 8 shows aggregated Misc_Named and Electric Other (Misc_Other) end-use intensity projections.

Figure 8: Miscellaneous Intensity Trends (kWh/household)



The 2021 SAE spreadsheets include separate intensity projections for total Misc_Named and Misc_Other. One modeling option to consider is to estimate Misc_Other for your own service area by only including Misc_Named in the XOther variable and incorporating a separate trend variable to account for unclassified miscellaneous sales.

Electric Vehicle (EV) and Photovoltaic (PV) Input Spreadsheets

In prior spreadsheets the EV and PV worksheets were populated with generic data and did not include assumptions for calculating use per customer impacts; the worksheets were designed to allow the user to input their own EV and PV assumptions and import the intensities into their residential sales forecast model. This year we updated the EV and PV tabs to include EIA's forecast assumptions from AEO 2021 and include inputs for translating number of units to kWh impact. Figure 9 shows the electric vehicle (EV) worksheet.

Figure 9: EV Worksheet

Year	Households	Vehicles Per HH	Vehicles	Elec Stock Share	Elec Vehicles	AnnualMiles	MilesPerkWh	UEC	Sales	Intensity
2020	18,475,139	2.08	38,476,517	0.6%	223,071	12,000	3.08	3,895	868,907	47.0
2021	18,595,831	2.06	38,302,557	0.7%	253,055	12,000	3.00	3,995	1,011,047	54.4
2022	18,716,069	2.04	38,265,592	0.7%	285,221	12,000	2.95	4,061	1,158,385	61.9
2023	18,832,472	2.03	38,266,490	0.8%	317,951	12,000	2.93	4,097	1,302,487	69.2
2024	18,948,043	2.02	38,324,073	0.9%	352,472	12,000	2.92	4,112	1,449,536	76.5
2025	19,067,257	2.02	38,432,108	1.0%	391,500	12,000	2.91	4,123	1,614,334	84.7
2026	19,185,904	2.01	38,535,465	1.2%	443,427	12,000	2.92	4,114	1,824,201	95.1
2027	19,300,338	2.00	38,598,483	1.3%	499,937	12,000	2.93	4,098	2,048,513	106.1
2028	19,411,864	1.99	38,645,462	1.5%	560,897	12,000	2.94	4,083	2,290,403	118.0
2029	19,521,151	1.98	38,671,258	1.6%	625,184	12,000	2.95	4,072	2,545,819	130.4
2030	19,629,134	1.97	38,681,680	1.8%	694,663	12,000	2.95	4,063	2,822,301	143.8
2031	19,735,350	1.96	38,691,919	2.0%	769,648	12,000	2.96	4,055	3,121,195	158.2
2032	19,840,592	1.95	38,688,564	2.2%	850,650	12,000	2.96	4,050	3,444,768	173.6
2033	19,942,910	1.94	38,691,245	2.4%	938,116	12,000	2.97	4,045	3,794,622	190.3
2034	20,042,312	1.93	38,704,711	2.7%	1,032,268	12,000	2.97	4,041	4,171,581	208.1
2035	20,141,631	1.92	38,717,511	2.9%	1,132,777	12,000	2.97	4,038	4,574,628	227.1
2036	20,238,442	1.91	38,722,361	3.2%	1,239,285	12,000	2.97	4,036	5,002,164	247.2
2037	20,333,673	1.90	38,731,368	3.5%	1,352,300	12,000	2.97	4,035	5,455,879	268.3
2038	20,428,323	1.90	38,745,562	3.8%	1,471,953	12,000	2.98	4,033	5,936,726	290.6
2039	20,522,184	1.89	38,754,018	4.1%	1,596,275	12,000	2.98	4,033	6,437,380	313.7
2040	20,616,078	1.88	38,756,935	4.5%	1,725,293	12,000	2.98	4,033	6,958,312	337.5

The data shown in red are inputs from the EIA's transportation forecast. The values shown in blue are calculations. The calculations are from left to right. The first two columns are census-level of number of households (column B) and average number of vehicles per household (column C). The product gives total number of vehicles (column D). Column E is EIA's EV saturation forecast. Total EVs are the product of total vehicles and expected EV saturation (column F). The other key inputs are expected annual miles driven (column G) and projected kWh per mile (column H). While EV efficiency is expected to improve the average kWh per mile increase as a result total electric or battery electric vehicles (BEV) gaining market share over plug-in hybrid electric vehicles (PHEV). The annual use per car (UEC, column I) is calculated as the annual miles divided by average vehicle efficiency (kWh per mile). Total EV sales (column J) are calculated as the product of EV vehicle stock and vehicle UEC. The EV chagrining intensity is derived by dividing total EV sales by total number of Households (column K). You can add EV to XOther model variable or translate to a monthly EV charging sales and add to your residential average use forecast.

The PV worksheet is shown in Figure 10.

Figure 2: PV Worksheet

Year	PVInstalls	PV Stock	AvgPVSize	PVStockKW	PVDecayRate	AdjPV_KW	CapacityFactor	Generation MWh	OwnUse Share	OwnUse MWh	Excess MWh	OwnUse Intensity
2020	161,737	1,480,572	5.69	8,427,376	0.01	8,353,615	16.3%	11,950,441	80%	9,560,353	2,390,088	(517.5)
2021	168,564	1,649,136	5.78	9,539,898	0.01	9,455,624	16.3%	13,473,487	80%	10,778,789	2,694,697	(579.6)
2022	136,616	1,785,751	5.85	10,455,222	0.01	10,359,823	16.2%	14,666,519	80%	11,733,215	2,933,304	(626.9)
2023	130,108	1,915,859	5.92	11,339,953	0.01	11,235,401	16.1%	15,812,419	80%	12,649,935	3,162,484	(671.7)
2024	126,292	2,042,151	5.97	12,198,741	0.01	12,085,341	16.0%	16,916,846	80%	13,533,477	3,383,369	(714.2)
2025	126,655	2,168,806	6.03	13,072,661	0.01	12,950,674	15.9%	18,046,720	80%	14,437,376	3,609,344	(757.2)
2026	130,489	2,299,295	6.08	13,986,083	0.01	13,855,356	15.9%	19,240,777	80%	15,392,621	3,848,155	(802.3)
2027	130,945	2,430,240	6.13	14,902,700	0.01	14,762,839	15.8%	20,439,922	80%	16,351,938	4,087,984	(847.2)
2028	130,855	2,561,095	6.18	15,831,768	0.01	15,682,741	15.8%	21,660,012	80%	17,328,009	4,332,002	(892.7)
2029	131,441	2,692,536	6.23	16,764,996	0.01	16,606,678	15.7%	22,887,264	80%	18,309,811	4,577,453	(937.9)
2030	133,668	2,826,203	6.27	17,727,400	0.01	17,559,750	15.7%	24,162,616	80%	19,330,093	4,832,523	(984.8)
2031	138,523	2,964,726	6.32	18,724,768	0.01	18,547,494	15.7%	25,495,225	80%	20,396,180	5,099,045	(1,033.5)
2032	140,343	3,105,069	6.36	19,749,272	0.01	19,562,024	15.7%	26,872,751	80%	21,498,200	5,374,550	(1,083.5)
2033	142,981	3,248,050	6.40	20,793,032	0.01	20,595,539	15.7%	28,282,121	80%	22,625,696	5,656,424	(1,134.5)
2034	144,976	3,393,026	6.44	21,865,852	0.01	21,657,922	15.7%	29,740,184	80%	23,792,147	5,948,037	(1,187.1)
2035	147,081	3,540,107	6.48	22,954,248	0.01	22,735,590	15.7%	31,223,908	80%	24,979,127	6,244,782	(1,240.2)
2036	148,160	3,688,266	6.52	24,065,444	0.01	23,835,902	15.7%	32,745,884	80%	26,196,707	6,549,177	(1,294.4)
2037	149,685	3,837,951	6.56	25,188,080	0.01	24,947,426	15.7%	34,287,059	80%	27,429,647	6,857,412	(1,349.0)
2038	150,079	3,988,030	6.60	26,328,676	0.01	26,076,795	15.7%	35,858,452	80%	28,686,761	7,171,690	(1,404.3)
2039	151,399	4,139,429	6.64	27,479,312	0.01	27,216,025	15.7%	37,447,143	80%	29,957,714	7,489,429	(1,459.8)
2040	152,841	4,292,270	6.68	28,656,188	0.01	28,381,395	15.7%	39,079,937	80%	31,263,949	7,815,987	(1,516.5)

The calculations are left to right, starting with the number households (column B) and number of installed systems (column C). EIA inputs are shown in red, the data shown in green illustrates the user-defined inputs and the calculations are shown blue. Total stock (column D) is calculated as the cumulation of number of installed systems (column C). Installed kW capacity (column F) is the product of PV Stock and average PV size (column E). Capacity projection can be adjusted for solar degradation by setting a decay rate (column G); Adjusted kW capacity (column H) is calculated by applying the decay rate to prior year PV capacity estimate. Solar Generation (column J) is derived by applying the capacity factor (column I) to adjusted installed capacity. Total solar generation is split into own-use (that consumed by the customer) and excess (that sold back to the grid). Own-use intensity (column N) is calculated by dividing own-use generation by the number of households. The PV own-use intensity can be imported into your residential forecast file and used to adjust your residential average use forecast.

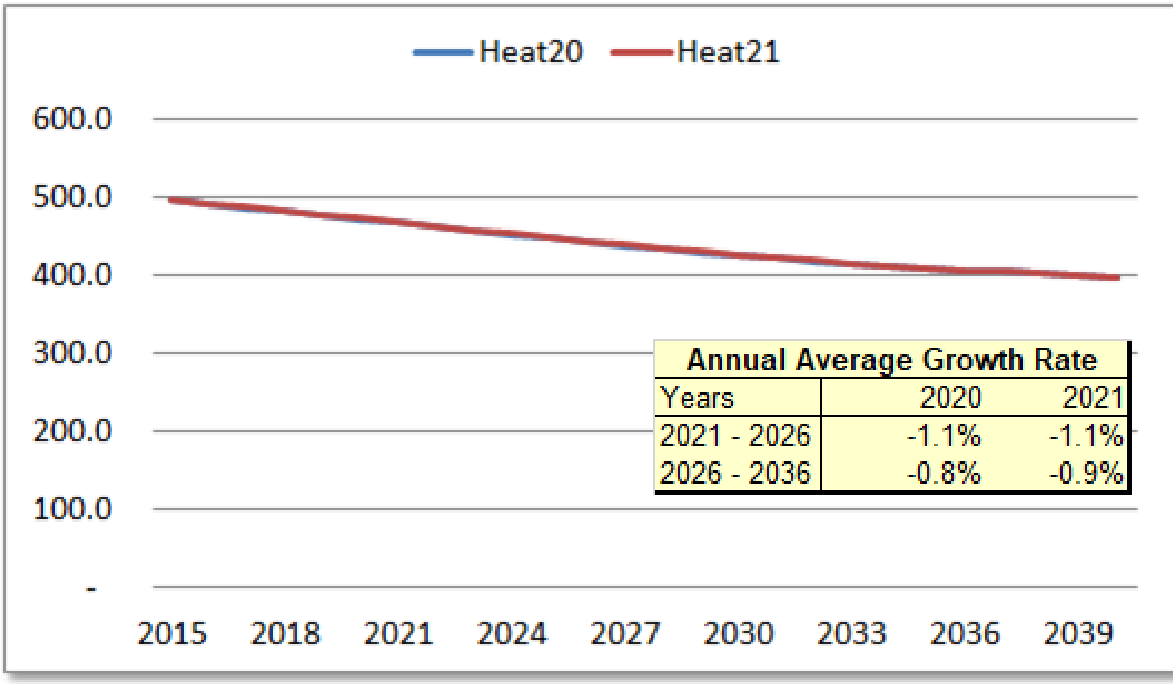
Natural Gas

Space heating and water heating account for 95% of residential natural gas usage, with cooking and clothes dryers accounting for the remainder. At the U.S. level, roughly 50% of households have gas space and water heating. The share of homes with gas space heat has been relatively constant and is expected to increase just slightly over the next 20 years.

Gas Heating

Over the last 10 years, there have been significant improvements in heating system efficiency and housing thermal insulation; these gains are expected to continue over the next thirty years. Given a relatively flat saturation, efficiency improvements drive gas intensity lower. Gas heating intensity starts at a higher usage level because of the calibration into the new 2015 base year, but then declines at a faster rate driven by slightly stronger improvements in gas system efficiency and thermal shell integrity. Figure 11 compares the 2020 and 2021 gas heating intensity projections.

Figure 11: U.S. Gas Heating Intensity (therms/household)



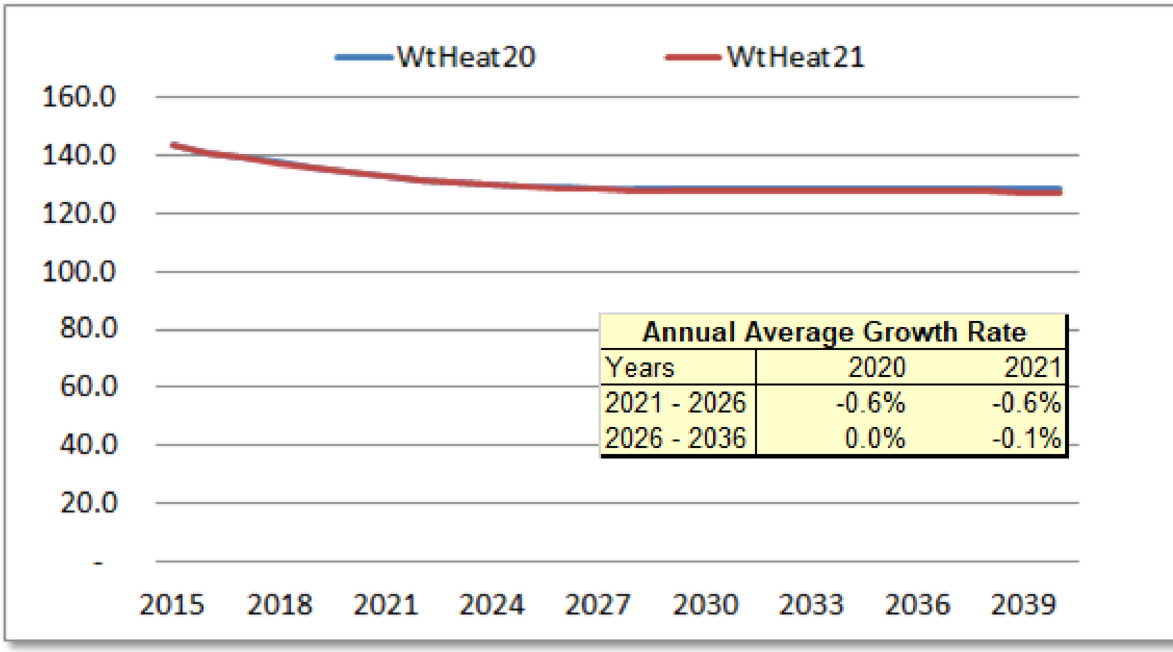
Annual Average Growth Rate		
Years	2020	2021
2021 - 2026	-1.1%	-1.1%
2026 - 2036	-0.8%	-0.9%

The 2021 natural gas heating projections decline slightly faster than in 2020 forecast in the later part of the forecast period.

Water Heating

Water heating is the second largest gas end use, accounting for approximately 30% of residential natural gas usage. As with furnaces and gas boilers, water heaters have seen significant improvements in energy efficiency. Because efficiency has been increasing while saturation has been flat to declining, gas water heating intensity has also been declining. Figure 12 compares the 2020 and 2021 gas water heating intensity forecasts.

Figure 12: U.S. Gas Water Heating Intensity (therms/household)

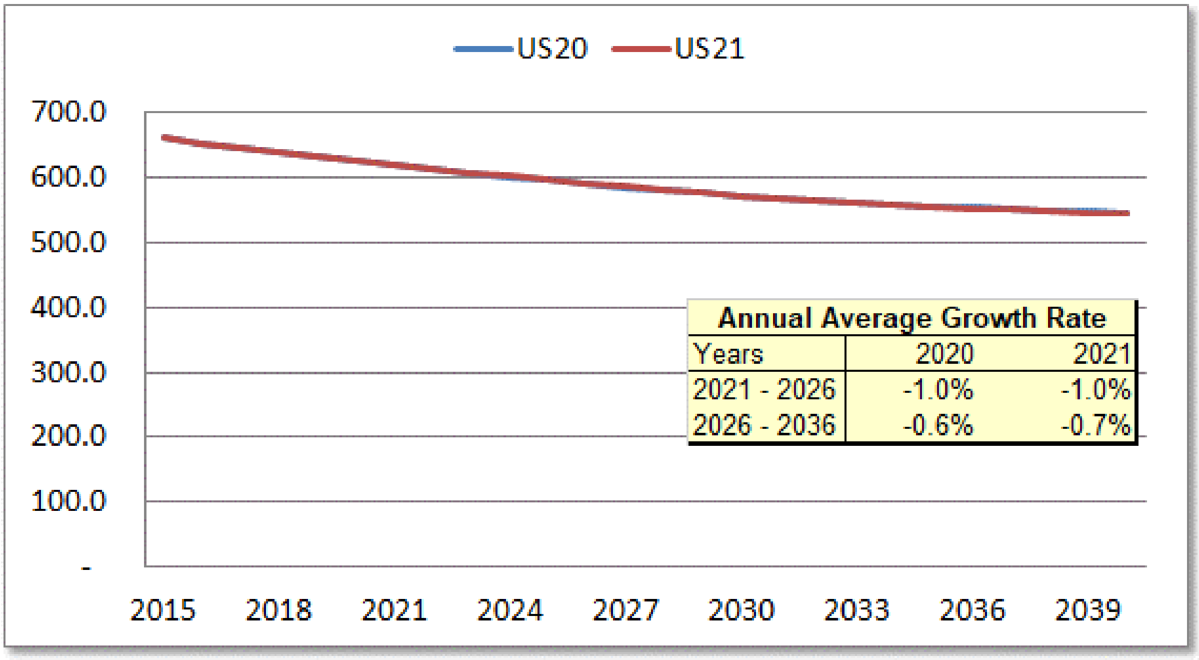


Annual Average Growth Rate		
Years	2020	2021
2021 - 2026	-0.6%	-0.6%
2026 - 2036	0.0%	-0.1%

The difference in intensities is small. As with heating, the 2021 intensity declines a slightly faster rate between 2026 and 2036.

Gas cooking energy intensities are also projected to decline through the forecast horizon whereas dryer use is expected to increase slightly. When all gas appliances are aggregated, total residential gas intensity averages 1.0% annual decline over the next 5 years and 0.7% thereafter. 2021 gas intensity forecast falls slightly faster than the 2020 forecast after 2026. Figure 13 shows total residential gas intensity forecast.

Figure 13: U.S. Residential Gas Intensity (therms/household)



Summary

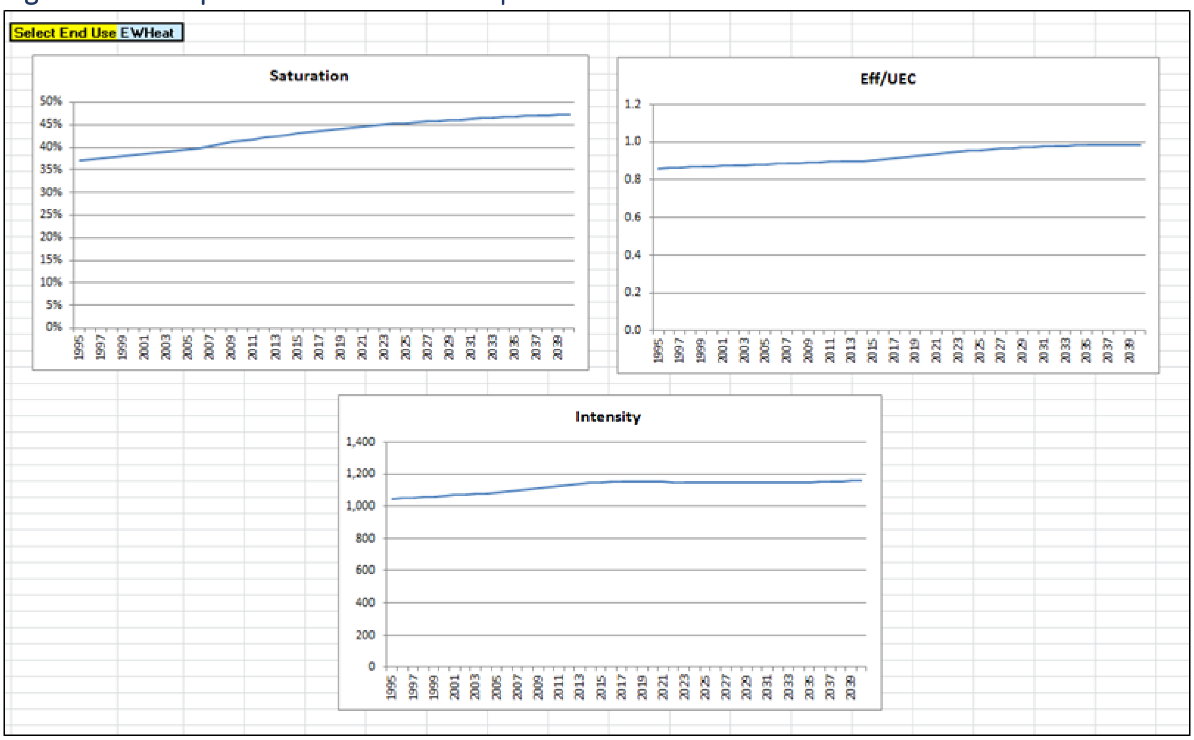
Overall, there is little change in residential electric and natural gas projections from last year's forecast. Miscellaneous usage is still the largest contributor to growth in the residential electric sector. With this in mind, we have separated miscellaneous use for specific end uses from miscellaneous other use.

Appendix A:
Using the SAE Spreadsheets

Updates to the SAE Spreadsheets

Itron continually works to simplify and improve the SAE spreadsheets to allow analysts to view end-use intensity trends, to understand how the indices are calculated, and to customize the SAE inputs (such as end-use saturations and starting UEC) to their own service area. Last year, Itron added a new *Graph* tab that allows the analyst to select an end-use and graph the end-use saturation, efficiency/UEC, and calculated intensity. Figure 14 shows this feature for electric water heaters.

Figure 14: SAE Spreadsheet End-Use Graph - Electric Water Heat



SAE Spreadsheet Organization

The SAE spreadsheets are organized to allow the analyst to calibrate end-use intensities to a specific utility service area organization where service area specific saturation and UEC estimates are available. The spreadsheet tabs include:

- **Definitions** provides descriptive information about end-uses, units and brief descriptions of the other worksheets.
- **EIAData** contains EIA efficiency, consumption, equipment stock, household, floor space and price projections.

- **Calibration** provides base year usage information. It can also be used to customize the spreadsheet to the user's service territory. Figure 15 shows the layout of the Calibration worksheet.

Figure 15: Calibration Worksheet

	A	B	C	D	E	F	G	H	I	J	K
1	Base Year (2009)	EFurn	HPHeat	GHPHeat	SecHt	CAC	HPCool	GHPCool	RAC	EWHeat	ECook
2	Consumption (mmBtu)	295,156,965	49,006,093	3,298,852	60,466,462	469,614,726	92,426,664	4,189,994	68,043,412	428,267,637	104,815,834
3	Equipment Stock (units)	29,626,185	9,099,838	699,168	28,312,038	61,707,187	9,099,838	699,168	49,101,682	46,763,693	68,137,629
4	UEC (kWh/unit)	2,920	1,578	1,383	626	2,230	2,977	1,756	406	2,684	451
5	Share (%)	26.0%	8.0%	0.6%	23.4%	54.2%	8.0%	0.6%	43.1%	41.1%	59.9%
6	Raw Intensity (kWh/year)	760	126	8	147	1,209	238	11	175	1,103	270
7	Model-Scaled Intensity (kWh/year)	760	126	8	147	1,209	238	11	175	1,103	270
8											
9	Observed Use Per Customer (kWh/year)	11,909									
10	Adjustment Factor	1.010									
11	Adjusted Intensity (kWh/year)	768	127	9	148	1,222	240	11	177	1,114	273
12											
13	XHeat	1.000									
14	XCool	1.000									
15	XOther	1.000									
16											

Base-year use-per-customer (kWh) for the utility service area is depicted in Row 9 and can be used to calibrate the spreadsheet to the user's service territory. To do this, substitute your weather-normalized average use for the Census Division average-use in Cell B9.

In additional to basic calibration to observed usage, in 2017 we have also added another layer of calibration to better tailor the regional data to utility-specific conditions. In order to get better starting estimates of electric usage by end use, we have utilized MetrixND models to "true up" EIA estimates to the regions. You can do this on the utility level by substituting the adjustment factors in cells B13-15 with estimated coefficients on SAE variables in your residential model. Figure 16 below provides an example.

Figure 16: Model-Based Calibration

	A	B	C	D	E	F	G	H	I	J	K
1	Base Year (2009)	EFurn	HPHeat	GHPHeat	SecHt	CAC	HPCool	GHPCool	RAC	EWHeat	ECook
2	Consumption (mmBtu)	295,156,965	49,006,093	3,298,852	60,466,462	469,614,726	92,426,664	4,189,994	68,043,412	428,267,637	104,815,834
3	Equipment Stock (units)	29,626,185	9,099,838	699,168	28,312,038	61,707,187	9,099,838	699,168	49,101,682	46,763,693	68,137,629
4	UEC (kWh/unit)	2,920	1,578	1,383	626	2,230	2,977	1,756	406	2,684	451
5	Share (%)	26.0%	8.0%	0.6%	23.4%	54.2%	8.0%	0.6%	43.1%	41.1%	59.9%
6	Raw Intensity (kWh/year)	760	126	8	147	1,209	238	11	175	1,103	270
7	Model-Scaled Intensity (kWh/year)	1,853	308	21	358	2,389	470	21	346	677	166
8											
9	Observed Use Per Customer (kWh/year)	11,909									
10	Adjustment Factor	0.999									
11	Adjusted Intensity (kWh/year)	1,852	307	21	357	2,387	470	21	346	677	166
12											
13	XHeat	2.438									
14	XCool	1.975									
15	XOther	0.614									
16											

In this case, model-based calibration adjusts heating and cooling starting year usage up based on model coefficients estimated from observed use per customer data. Other usage is adjusted downward.

Resulting end-use intensities are written to the *Intensities* tab. MetrixND project files can link to the *Intensities* tab as the source-data for the constructing of SAE model variables.

StructuralVars

This worksheet contains data about the size of homes and their building shell efficiencies. The results of the calculations on this tab are used in the development of energy intensities for heating and cooling end-uses.

Analysts can substitute local household and floor space estimates for the regional estimates to reflect local conditions in the final energy intensities. Total floor space can be modified in Column E and number of households in Column I.

Shares

The *Shares* tab contains historical saturation estimates and forecasts developed by the EIA. Data from appliance saturation surveys can be used to modify the default saturations. Depending on data availability, these changes can either shift the projections up or down (one survey) or modify the growth rate in the trends (two or more surveys).

Efficiencies

The *Efficiencies* tab provides historical and forecasted end-use efficiency. UEC estimates are used as a proxy for efficiency where specific technology efficiency data (as central air conditioner SEER) are not available. Efficiency trends can also be modified to reflect the utility service area. As a practical matter however, average efficiency for most equipment varies little between regions.

Intensities

Intensities are per-household end-use energy estimate derived from combining end-use saturation, efficiency, and starting UEC. If the user changes saturation and/or efficiency, the changes are reflected in the end-use intensity calculations.

MonthlyMults

The *MonthlyMults* tab provides seasonal multipliers for non-HVAC end-uses. This allows us to accurately gauge seasonal usage for such non weather-sensitive end-uses as water heating, refrigeration and lighting.

Graphs

The *Graphs* tab provides an interface to select an end-use and view historical and projected end-use saturation, efficiency (or UEC where an efficiency measure is not available) and resulting end-use intensity.

EV

Electric vehicle load is added to the base (other) end-use in the SAE model. Input data rows are highlighted in red and include:

- **Households.** Historical and forecasted number of households (column B)
- **EVSold.** Number of EV vehicles sold in any given year (column C)
- **EVDecay.** Number of EV vehicles removed (column D)
- **AnnualMiles.** Annual average miles driven (column G)
- **MilePerKwh.** Average vehicle efficiency (column H)

Additional columns include:

- **EVStock.** Calculated as the sum of all new purchases minus vehicle decay (column E).
- **Share.** The share of households with EVs (column F), calculated as EVStock / Households.
- **UEC.** The Unit Energy Consumption (kWh) for those households that own an EV. Calculated as the number of miles driven divided by the average vehicle miles per kWh (column I).
- **ShareUEC.** Use per household (column K), calculated by multiplying the vehicle UEC and the share of households that own an EV. The resulting annual EV energy intensity is on a kWh per household basis and can be added to the base or other use index in the SAE model.

PV

The SAE spreadsheets also include a worksheet for calculating PV (photovoltaic) energy impacts. Input data rows are highlighted in red and include:

- **Households.** Historical and forecasted Households or customers (column B)
- **PVInstalls.** Number of new PV installations (column C)
- **AvgPVSize.** Average PV kW capacity (column E)
- **PVDecayKW.** PV capacity decay in kW (column G)
- **CapacityFactor.** Capacity Factor (column I)

Additional columns include:

- **PVStockKW.** Estimated PV kW capacity (column H), calculated by summing current and all past PV installed capacity and subtracting the decay, calculated as:

	A	B	C	D	E	F	G	H	I	J	K
1	Base Year (2009)	EFurn	HPHeat	GHPHeat	SecHt	CAC	HPCool	GHPCool	RAC	EWHeat	ECook
2	Consumption (mmBtu)	295,156,965	49,006,093	3,298,852	60,466,462	469,614,726	92,426,664	4,189,994	68,043,412	428,267,637	104,815,834
3	Equipment Stock (units)	29,626,185	9,099,838	699,168	28,312,038	61,707,187	9,099,838	699,168	49,101,682	46,763,693	68,137,629
4	UEC (kWh/unit)	2,920	1,578	1,383	626	2,230	2,977	1,756	406	2,684	451
5	Share (%)	26.0%	8.0%	0.6%	23.4%	54.2%	8.0%	0.6%	43.1%	41.1%	59.9%
6	Raw Intensity (kWh/year)	760	126	8	147	1,209	238	11	175	1,103	270
7	Model-Scaled Intensity (kWh/year)	1,853	308	21	358	2,389	470	21	346	677	166
8											
9	Observed Use Per Customer (kWh/year)	11,909									
10	Adjustment Factor	0.999									
11	Adjusted Intensity (kWh/year)	1,852	307	21	357	2,387	470	21	346	677	166
12											
13	XHeat	2.438									
14	XCool	1.975									
15	XOther	0.614									
16											

- **PVEnergy.** PV MWh (column J) is derived by applying the capacity factor to the PV Capacity Stock, calculated as:

$$(PVStockKW \times 8760 \times CapacityFactor)/1000$$

- **ShareUEC.** Final PV energy intensity (column K) is derived by dividing PVEnergy by total number of households. The estimate is negative, as it represents a load reduction.

Appendix B:
Residential SAE Modeling Framework

The traditional approach to forecasting monthly sales for a customer class is to develop an econometric model that relates monthly sales to weather, seasonal variables, and economic conditions. From a forecasting perspective, econometric models are well suited to identifying historical trends and to projecting these trends into the future. In contrast, end-use models can incorporate the end-use factors driving energy use. By including end-use structure in an econometric model, the statistically adjusted end-use (SAE) modeling framework exploits the strengths of both approaches.

There are several advantages to this approach.

- The equipment efficiency and saturation trends, dwelling square footage, and thermal integrity changes embodied in the long-run end-use forecasts are introduced explicitly into the short-term monthly sales forecast. This provides a strong bridge between the two forecasts.
- By explicitly incorporating trends in equipment saturations, equipment efficiency, dwelling square footage, and thermal integrity levels, it is easier to explain changes in usage levels and changes in weather-sensitivity over time.
- Data for short-term models are often not sufficiently robust to support estimation of a full set of price, economic, and demographic effects. By bundling these factors with equipment-oriented drivers, a rich set of elasticities can be incorporated into the final model.

This section describes this approach, the associated supporting SAE spreadsheets, and the MetrixND project files that are used in the implementation. The main source of the residential SAE spreadsheets is the 2020 Annual Energy Outlook (AEO) database provided by the Energy Information Administration (EIA).

Statistically Adjusted End-Use Modeling Framework

The statistically adjusted end-use modeling framework begins by defining energy use ($USE_{y,m}$) in year (y) and month (m) as the sum of energy used by heating equipment ($Heat_{y,m}$), cooling equipment ($Cool_{y,m}$), and other equipment ($Other_{y,m}$). Formally,

$$USE_{y,m} = Heat_{y,m} + Cool_{y,m} + \mathrm{Other}_{y,m} \qquad (1)$$

Although monthly sales are measured for individual customers, the end-use components are not. Substituting estimates for the end-use elements gives the following econometric equation.

$$USE_m = a + b_1 \times XHeat_m + b_2 \times XCool_m + b_3 \times XOther_m + \varepsilon_m \qquad (2)$$

$XHeat_m$, $XCool_m$, and $XOther_m$ are explanatory variables constructed from end-use information, dwelling data, weather data, and market data. As will be shown below, the equations used to construct these X-variables are simplified end-use models, and the X-variables are the estimated usage levels for each of the major end uses based on these models. The estimated model can then be thought of as a statistically adjusted end-use model, where the estimated slopes are the adjustment factors.

Constructing XHeat

As represented in the SAE spreadsheets, energy use by space heating systems depends on the following types of variables.

- Heating degree days
- Heating equipment saturation levels
- Heating equipment operating efficiencies
- Average number of days in the billing cycle for each month
- Thermal integrity and footage of homes
- Average household size, household income, and energy prices

The heating variable is represented as the product of an annual equipment index and a monthly usage multiplier. That is:

$$XHeat_{y,m} = HeatIndex_{y,m} \times HeatUse_{y,m} \tag{3}$$

Where:

- $XHeat_{y,m}$ is estimated heating energy use in year (y) and month (m)
- $HeatIndex_{y,m}$ is the monthly index of heating equipment
- $HeatUse_{y,m}$ is the monthly usage multiplier

The heating equipment index is defined as a weighted average across equipment types of equipment saturation levels normalized by operating efficiency levels. Given a set of fixed weights, the index will change over time with changes in equipment saturations (*Sat*), operating efficiencies (*Eff*), building structural index ($StructuralIndex$), and energy prices. Formally, the equipment index is defined as:

$$HeatIndex_y = StructuralIndex_y \times \sum_{Type} Weight^{Type} \times \frac{\left(Sat_y^{Type} \big/ Eff_y^{Type}\right)}{\left(Sat_{15}^{Type} \big/ Eff_{15}^{Type}\right)} \tag{4}$$

The $StructuralIndex$ is constructed by combining the EIA's building shell efficiency index trends with surface area estimates, and then it is indexed to the 2015 value:

$$StructuralIndex_y = \frac{BuildingShellEfficiencyIndex_y \times SurfaceArea_y}{BuildingShellEfficiencyIndex_{15} \times SurfaceArea_{15}} \tag{5}$$

The $StructuralIndex$ is defined on the *StructuralVars* tab of the SAE spreadsheets. Surface area is derived to account for roof and wall area of a standard dwelling based on the regional average square footage data obtained from EIA. The relationship between the square footage and surface area is constructed assuming an aspect ratio of 0.75 and an average of 25% two-story and 75% single-story. Given these assumptions, the approximate linear relationship for surface area is:

$$SurfaceArea_y = 892 + 1.44 \times Footage_y \tag{6}$$

In Equation 4, 2015 is used as a base year for normalizing the index. As a result, the ratio on the right is equal to 1.0 in 2015. In other years, it will be greater than 1.0 if equipment saturation levels are above their 2015 level. This will be counteracted by higher efficiency levels, which will drive the index downward. The weights are defined as follows.

$$Weight^{Type} = \frac{Energy_{15}^{Type}}{HH_{15}} \times HeatShare_{15}^{Type} \quad (7)$$

In the SAE spreadsheets, these weights are referred to as Intensities and are defined on the *EIAData* tab. With these weights, the $HeatIndex$ value in 2015 will be equal to estimated annual heating intensity per household in that year. Variations from this value in other years will be proportional to saturation and efficiency variations around their base values.

For electric heating equipment, the SAE spreadsheets contain two equipment types: electric resistance furnaces/room units and electric space heating heat pumps. Examples of weights for these two equipment types for the U.S. are given in Table 1.

Table 1: Electric Space Heating Equipment Weights

Equipment Type	Weight (kWh)
Electric Resistance Furnace/Room units	916
Electric Space Heating Heat Pump	346

Data for the equipment saturation and efficiency trends are presented on the *Shares* and *Efficiencies* tabs of the SAE spreadsheets. The efficiency for electric space heating heat pumps are given in terms of Heating Seasonal Performance Factor [BTU/Wh], and the efficiencies for electric furnaces and room units are estimated as 100%, which is equivalent to 3.41 BTU/Wh.

Price Impacts. In the 2007 version of the SAE models and thereafter, the Heat Index has been extended to account for the long-run impact of electric and natural gas prices. Since the Heat Index represents changes in the stock of space heating equipment, the price impacts are modeled to play themselves out over a 10-year horizon. To introduce price effects, the Heat Index as defined by Equation 4 above is multiplied by a 10-year moving-average of electric and gas prices. The level of the price impact is guided by the long-term price elasticities:

$$HeatIndex_y = StructuralIndex_y \times \sum_{Type} Weight^{Type} \times \frac{\left(Sat_y^{Type} \big/ Eff_y^{Type}\right)}{\left(Sat_{15}^{Type} \big/ Eff_{15}^{Type}\right)} \times \left(TenYearMovingAverageElectric\,Price_{y,m}\right)^{\varphi} \times \left(TenYearMovingAverageGas\,Price_{y,m}\right)^{\gamma} \quad (8)$$

Since the trends in the Structural index (the equipment saturations and efficiency levels) are provided exogenously by the EIA, the price impacts are introduced in a multiplicative form. As a result, the long-run change in the Heat Index represents a combination of adjustments to the structural integrity of new homes, saturations in equipment and efficiency levels relative to what was contained in the base EIA long-term forecast.

Heating system usage levels are impacted on a monthly basis by several factors, including weather, household size, income levels, prices, and billing days. The estimates for space heating equipment usage levels are computed as follows:

$$HeatUse_{y,m} = \left(\frac{WgtHDD_{y,m}}{HDD_{15}}\right) \times \left(\frac{HHSize_y}{HHSize_{15}}\right)^{0.25} \times \left(\frac{Income_y}{Income_{15}}\right)^{0.20} \times \left(\frac{ElecPrice_{y,m}}{ElecPrice_{15,7}}\right)^{\lambda} \times \left(\frac{GasPrice_{y,m}}{GasPrice_{15,7}}\right)^{\kappa} \quad (9)$$

Where:

- *WgtHDD* is the weighted number of heating degree days in year (y) and month (m). This is constructed as the weighted sum of the current month's HDD and the prior month's HDD. The weights are 75% on the current month and 25% on the prior month.
- *HDD* is the annual heating degree days for 2015
- *HHSize* is average household size in a year (y)
- *Income* is average real income per household in year (y)
- *ElecPrice* is the average real price of electricity in month (m) and year (y)
- *GasPrice* is the average real price of natural gas in month (m) and year (y)

By construction, the $HeatUse_{y,m}$ variable has an annual sum that is close to 1.0 in the base year (2015). The first two terms, which involve billing days and heating degree days, serve to allocate annual values to months of the year. The remaining terms average to 1.0 in the base year. In other years, the values will reflect changes in the economic drivers, as transformed through the end-use elasticity parameters. The price impacts captured by the Usage equation represent short-term price response.

Constructing XCool

The explanatory variable for cooling loads is constructed in a similar manner. The amount of energy used by cooling systems depends on the following types of variables.

- Cooling degree days
- Cooling equipment saturation levels
- Cooling equipment operating efficiencies
- Average number of days in the billing cycle for each month
- Thermal integrity and footage of homes
- Average household size, household income, and energy prices

The cooling variable is represented as the product of an equipment-based index and monthly usage multiplier. That is,

$$XCool_{y,m} = CoolIndex_y \times CoolUse_{y,m} \quad (10)$$

Where

- $XCool_{y,m}$ is estimated cooling energy use in year (y) and month (m)
- $CoolIndex_y$ is an index of cooling equipment
- $CoolUse_{y,m}$ is the monthly usage multiplier

As with heating, the cooling equipment index is defined as a weighted average across equipment types of equipment saturation levels normalized by operating efficiency levels. Formally, the cooling equipment index is defined as:

$$CoolIndex_y = StructuralIndex_y \times \sum_{Type} Weight^{Type} \times \frac{\left(Sat_y^{Type} \big/ Eff_y^{Type} \right)}{\left(Sat_{15}^{Type} \big/ Eff_{15}^{Type} \right)} \quad (11)$$

Data values in 2015 are used as a base year for normalizing the index, and the ratio on the right is equal to 1.0 in 2015. In other years, it will be greater than 1.0 if equipment saturation levels are above their 2015 level. This will be counteracted by higher efficiency levels, which will drive the index downward. The weights are defined as follows.

$$Weight^{Type} = \frac{Energy_{15}^{Type}}{HH_{15}} \times CoolShare_{15}^{Type} \quad (12)$$

In the SAE spreadsheets, these weights are referred to as Intensities and are defined on the *EIAData* tab. With these weights, the $CoolIndex$ value in 2015 will be equal to estimated annual cooling intensity per household in that year. Variations from this value in other years will be proportional to saturation and efficiency variations around their base values.

For cooling equipment, the SAE spreadsheets contain three equipment types: central air conditioning, space cooling heat pump, and room air conditioning. Examples of weights for these three equipment types for the U.S. are given in Table 2.

Table 2: Space Cooling Equipment Weights

Equipment Type	Weight (kWh)
Central Air Conditioning	1,012
Space Cooling Heat Pump	306
Room Air Conditioning	277

The equipment saturation and efficiency trends data are presented on the *Shares* and *Efficiencies* tabs of the SAE spreadsheets. The efficiency for space cooling heat pumps and central air conditioning (A/C) units are given in terms of Seasonal Energy Efficiency Ratio [BTU/Wh], and room A/C units efficiencies are given in terms of Energy Efficiency Ratio [BTU/Wh].

Price Impacts. In the 2007 SAE models and thereafter, the Cool Index has been extended to account for changes in electric and natural gas prices. Since the Cool Index represents changes in the stock of space heating equipment, it is anticipated that the impact of prices will be long-term in nature. The Cool Index as defined Equation 11 above is then multiplied by a 10-year moving average of electric and gas prices. The level of the price impact is guided by the long-term price elasticities.

$$CoolIndex_y = StructuralIndex_y \times \sum_{Type} Weight^{Type} \times \frac{\left(Sat_y^{Type} \big/ Eff_y^{Type}\right)}{\left(Sat_{15}^{Type} \big/ Eff_{15}^{Type}\right)} \times$$

$$\left(TenYearMovingAverageElectric\,Pr\,i\,ce_{y,m}\right)^{\varphi} \times \left(TenYearMovingAverageGas\,Pr\,i\,ce_{y,m}\right)^{\gamma} \quad (13)$$

Since the trends in the Structural index, equipment saturations and efficiency levels are provided exogenously by the EIA, price impacts are introduced in a multiplicative form. The long-run change in the Cool Index represents a combination of adjustments to the structural integrity of new homes, saturations in equipment and efficiency levels. Without a detailed end-use model, it is not possible to isolate the price impact on any one of these concepts.

Cooling system usage levels are impacted on a monthly basis by several factors, including weather, household size, income levels, and prices. The estimates of cooling equipment usage levels are computed as follows:

$$CoolUse_{y,m} = \left(\frac{WgtCDD_{y,m}}{CDD_{15}}\right) \times \left(\frac{HHSize_y}{HHSize_{15}}\right)^{0.25} \times \left(\frac{Income_y}{Income_{15}}\right)^{0.20} \times$$

$$\left(\frac{Elec\,Pr\,ice_{y,m}}{Elec\,Pr\,ice_{15}}\right)^{\lambda} \times \left(\frac{Gas\,Pr\,ice_{y,m}}{Gas\,Pr\,ice_{15}}\right)^{\kappa} \quad (14)$$

Where:

- $WgtCDD$ is the weighted number of cooling degree days in year (y) and month (m). This is constructed as the weighted sum of the current month's CDD and the prior month's CDD. The weights are 75% on the current month and 25% on the prior month.
- CDD is the annual cooling degree days for 2015.

By construction, the $CoolUse$ variable has an annual sum that is close to 1.0 in the base year (2015). The first two terms, which involve billing days and cooling degree days, serve to allocate annual values to months of the year. The remaining terms average to 1.0 in the base year. In other years, the values will change to reflect changes in the economic driver changes.

Constructing XOther

Monthly estimates of non-weather sensitive sales can be derived in a similar fashion to space heating and cooling. Based on end-use concepts, other sales are driven by:

- Appliance and equipment saturation levels
- Appliance efficiency levels
- Average number of days in the billing cycle for each month
- Average household size, real income, and real prices

The explanatory variable for other uses is defined as follows:

$$XOther_{y,m} = OtherEqpIndex_{y,m} \times OtherUse_{y,m} \tag{15}$$

The first term on the right-hand side of this expression ($OtherEqpIndex_y$) embodies information about appliance saturation and efficiency levels and monthly usage multipliers. The second term ($OtherUse$) captures the impact of changes in prices, income, household size, and number of billing-days on appliance utilization.

End-use indices are constructed in the SAE models. A separate end-use index is constructed for each end-use equipment type using the following function form.

$$ApplianceIndex_{y,m} = Weight^{Type} \times \frac{\left(Sat_y^{Type} \Big/ \frac{1}{UEC_y^{Type}}\right)}{\left(Sat_{15}^{Type} \Big/ \frac{1}{UEC_{15}^{Type}}\right)} \times MoMult_m^{Type} \times$$
$$(TenYearMovingAverageElectric\,Pr\,i\,ce)^{\lambda} \times$$
$$(TenYearMovingAverageGas\,Pr\,i\,ce)^{\kappa} \tag{16}$$

Where:

- $Weight$ is the weight for each appliance type
- Sat represents the fraction of households, who own an appliance type
- $MoMult_m$ is a monthly multiplier for the appliance type in month (m)
- Eff is the average operating efficiency the appliance
- UEC is the unit energy consumption for appliances

This index combines information about trends in saturation levels and efficiency levels for the main appliance categories with monthly multipliers for lighting, water heating, and refrigeration.

The appliance saturation and efficiency trends data are presented on the Shares and Efficiencies tabs of the SAE spreadsheets.

Further monthly variation is introduced by multiplying by usage factors that cut across all end uses, constructed as follows:

$$ApplianceUse_{y,m} = \left(\frac{BDays_{y,m}}{30.44}\right) \times \left(\frac{HHSize_y}{HHSize_{15}}\right)^{0.46} \times \left(\frac{Income_y}{Income_{15}}\right)^{0.10} \times$$
$$\left(\frac{Elec\,Pr\,ice_{y,m}}{Elec\,Pr\,ice_{15}}\right)^{\varphi} \times \left(\frac{Gas\,Pr\,ice_{y,m}}{Gas\,Pr\,ice_{15}}\right)^{\lambda} \tag{17}$$

The index for other uses is derived then by summing across the appliances:

$$OtherEqpIndex_{y,m} = \sum_k ApplianceIndex_{y,m} \times ApplianceUse_{y,m} \quad (18)$$

Supporting Spreadsheets and MetrixND Project Files

The SAE approach described above has been implemented for each of the nine Census Divisions. A mapping of states to Census Divisions is presented in Figure 17. This section describes the contents of each file and a procedure for customizing the files for specific utility data. A total of 18 files are provided. These files are listed in Table 3 and are now in xlsx Excel file format.

Figure 17: Mapping of States to Census Divisions

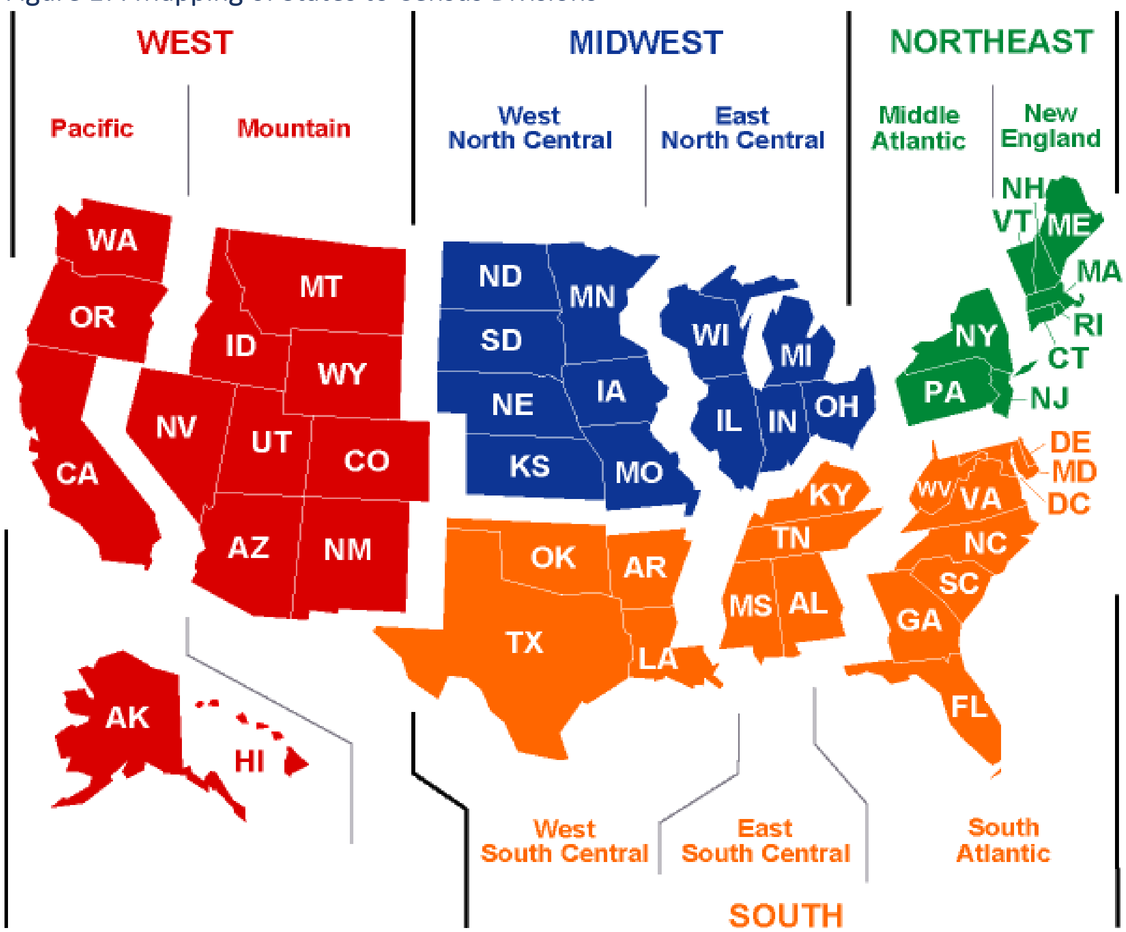


Table 3: List of SAE Files

Spreadsheet	MetrixND Project File
NewEngland.xlsx	SAE_NewEngland.ndm
MiddleAtlantic.xlsx	SAE_MiddleAtlantic.ndm
EastNorthCentral.xlsx	SAE_EastNorthCentral.ndm
WestNorthCentral.xlsx	SAE_WestNorthCentral.ndm
SouthAtlantic.xlsx	SAE_SouthAltantic.ndm
EastSouthCentral.xlsx	SAE_EastSouthCentral.ndm
WestSouthCentral.xlsx	SAE_WestSouthCentral.ndm
Mountain.xlsx	SAE_Mountain.ndm
Pacific.xlsx	SAE_Pacific.ndm

As defaults, the SAE spreadsheets include regional data, but utility data can be entered to generate the *Heat*, *Cool*, and *Other* equipment indices used in the SAE approach. The MetrixND project files link to the data in these spreadsheets. These project files calculate the end-use Usage variables are constructed and the estimated SAE models.

Each of the nine SAE spreadsheets contains the following tabs:

- **Definitions** contains equipment, end use, worksheet, and Census Division definitions.
- **Intensities** calculates the annual equipment indices.
- **Shares** contains historical and forecasted equipment shares. The default forecasted values are provided by the EIA. The raw EIA projections are provided on the *EIAData* tab.
- **Efficiencies** contains historical and forecasted equipment efficiency trends. The forecasted values are based on projections provided by the EIA. The raw EIA projections are provided on the *EIAData* tab.
- **StructuralVars** contains historical and forecasted square footage, number of households, building shell efficiency index, and calculation of structural variable. The forecasted values are based on projections provided by the EIA.
- **Calibration** contains calculations of the base year Intensity values used to weight the equipment indices.
- **EIAData** contains the raw forecasted data provided by the EIA.
- **MonthlyMults** contains monthly multipliers that are used to spread the annual equipment indices across the months.
- **EV** contains a worksheet for incorporating electric vehicle (EV) impacts.
- **PV** contains a worksheet for incorporating photovoltaic battery (PV) impacts.

The MetrixND Project files are linked to the *AnnualIndices*, *ShareUEC*, and *MonthlyMults* tabs in the spreadsheets. Sales, economic, price and weather information for the Census Division is provided in the linkless data table *UtilityData*. In this way, utility specific data and the equipment indices are brought into the project file. The MetrixND project files contain the objects described below.

Parameter Tables

- **Elas.** This parameter table includes the values of the elasticities used to calculate the Usage variables for each end-use. There are five types of elasticities included on this table.
    - Economic variable elasticities
    - Short-term own price elasticities
    - Short-term cross price elasticities
    - Long-term own price elasticities
    - Long-term cross price elasticities

The short-term price elasticities drive the end-use usage equations. The long-term price elasticities drive the Heat, Cool and other appliance indices. The combined price impact is an aggregation of the short and long-term price elasticities. As such, the long-term price elasticities are input as incremental price impact. That is, the long-term price elasticity is the difference between the overall price impact and the short-term price elasticity.

Data Tables

- **AnnualEquipmentIndices** links to the *AnnualIndices* tab for heating and cooling indices, and *ShareUEC* tab for water heating, lighting, and appliances in the SAE spreadsheet.
- **UtilityData** is a linkless data table that contains sales, price, economic and weather data specific to a given Census Division.
- **MonthlyMults** links to the corresponding tab in the SAE spreadsheet.

Transformation Tables

- **EconTrans** computes the average usage, and household size, household income, and price indices used in the usage equations.
- **WeatherTrans** computes the HDD and CDD indices used in the usage equations.
- **ResidentialVars** computes the *Heat*, *Cool* and *Other Usage* variables, as well as the *XHeat*, *XCool* and *XOther* variables that are used in the regression model.
- **BinaryVars** computes the calendar binary variables that could be required in the regression model.
- **AnnualFcst** computes the annual historical and forecast sales and annual change in sales.
- **EndUseFcst** computes the monthly sales forecasts by end uses.

Models

- **ResModel** is the Statistically Adjusted End-Use Model.

Steps to Customize the Files for Your Service Territory

The files that are distributed along with this document contain regional data. If you have more accurate data for your service territory, you are encouraged to tailor the spreadsheets with that information. This section describes the steps needed to customize the files.

Minimum Customization

- Save the MetrixND project file and the spreadsheet into the same folder
- Select the spreadsheet and MetrixND project file from the appropriate Census Division
- Open the spreadsheet and navigate to the *Calibration* tab
- In cell "B9", replace base year Census Division use-per-customer with observed use-per-customer for your service territory
- Save the spreadsheet and open the MetrixND project file
- Click on the *Update All Links* button on the *Menu* bar
- Review the model results

Further Customization of Starting Usage Levels

In addition to the minimum steps listed above, you can also utilize model-based calibration process described previously to further fine-tune starting year usage estimates to your service territory.

Customizing the End-use Share Paths

You can also install your own share history and forecasts. To do this, navigate to the *Share* tab in the spreadsheet and paste in the values for your region. Make sure that base year shares on the *Calibration* tab reflect changes on the *Shares* tab.

Customizing the End-use Efficiency Paths

Finally, you can override the end-use efficiency paths that are contained on the *Efficiencies* tab of the spreadsheet.

Variable	Value	Units	Definition
HSize_Ht	0.25		Household size elasticity for space heating
HIncm_Ht	0.2		Household income elasticity for space heating
HSize_Cl	0.25		Household size elasticity for space cooling
HIncm_Cl	0.2		Household income elasticity for space cooling
HSize_Oth	0.46		Household size elasticity for non HVAC end-uses
HIncm_Oth	0.1		Household income elasticity for non HVAC end-uses
ST_SpHeatUsageOwn	-0.1		Short term Space Heating Usage Own Price Elasticity
ST_SpCoolUsageOwn	-0.08		Short term Space Cooling Usage Own Price Elasticity
ST_WHeatUsageOwn	-0.08		Short term Water heat Usage Own Price Elasticity
ST_CookUsageOwn	-0.06		Short term Cooking Usage Own Price Elasticity
ST_RefUsageOwn	0		Short term Refrig/Freezer Usage Own Price Elasticity
ST_DishUsageOwn	-0.06		Short term Dishwasher Usage Own Price Elasticity
ST_CWashUsageOwn	-0.06		Short term Clothes Washer Usage Own Price Elasticity
ST_DryUsageOwn	-0.06		Short term Clothes Drying Usage Own Price Elasticity
ST_TVUsageOwn	-0.07		Short term TV Usage Own Price Elasticity
ST_FFUsageOwn	-0.1		Short term Furnace Fan Usage Own Price Elasticity
ST_LightUsageOwn	-0.08		Short term Lighting Usage Own Price Elasticity
ST_MiscUsageOwn	-0.06		Short term Misc Usage Own Price Elasticity
LT_SpHeatShrOwn	-0.15		Long term Space Heating Share/Efficiency Incremental Own Price Elastcity
LT_SpCollShrOwn	-0.11		Long term Space Cooling Share/Efficiency Incremental Own Price Elasticity
LT_WHeatShrOwn	-0.16		Long term Water heat Share/Efficiency Incremental Own Price Elasticity
LT_CookShrOwn	-0.08		Long term Cooking Share/Efficiency Own Incremental Price Elasticity
LT_RefShrOwn	-0.03		Long term Refrigeration/Freezer Share/Efficiency Own Incremental Price Elasticity
LT_DishShrOwn	-0.08		Long term Dishwasher Share/Efficiency Own Incremental Price Elasticity
LT_CWashShrOwn	-0.08		Long term Clothes Washer Share/Efficiency Own Incremental Price Elasticity
LT_DryShrOwn	-0.08		Long term Clothes Dryer Share/Efficiency Own Incremental Price Elasticity
LT_TVShrOwn	-0.08		Long term TV Share/Efficiency Own Incremental Price Elasticity
LT_FFShrOwn	-0.15		Long term Furnace Fan Share/Efficiency Incremental Own Price Elasticity
LT_LightShrOwn	-0.1		Long term Lighting Share/Efficiency Own Incremental Price Elasticity
LT_MiscShrOwn	-0.08		Long term Misc Share/Efficiency Own Incremental Price Elasticity
ST_SpHeatUsageCross	0.001		Short term Space Heating Usage Cross Price Elasticity
ST_SpCoolUsageCross	0		Short term Space Colling Usage Cross Price Elasticity
ST_WHeatUsageCross	0		Short term Water heat Usage Cross Price Elasticity
ST_CookUsageCross	0.001		Short term Cook Usage Cross Price Elasticity
ST_RefUsageCross	0		Short term Refrigeration/Freezer Usage Cross Price Elasticity
ST_DishUsageCross	0		Short term Dishwasher Usage Cross Price Elasticity
ST_CWashUsageCross	0		Short term Clothes Washer Usage Cross Price Elasticity
ST_DryUsageCross	0		Short term Dryer Usage Cross Price Elasticity
ST_TVUsageCross	0		Short term TV Usage Cross Price Elasticity
ST_FFUsageCross	0		Short term Furnace Fan Usage Cross Price Elasticity
ST_LightUsageCross	0		Short term Light Usage Cross Price Elasticity
ST_MiscUsageCross	0		Short term Misc Usage Cross Price Elasticity
LT_SpHeatShrCross	0.01		Long term Space Heating Share/Efficiency Incremental Cross Price Elasticity
LT_SpCoolShrCross	0		Long term Space Cooling Share/Efficiency Incremental Cross Price Elasticity
LT_WHeatShrCross	0.01		Long term Water heat Share/Efficiency Incremental Cross Price Elasticity
LT_CookShrCross	0.01		Long term Cook Share/Efficiency Incremental Cross Price Elasticity
LT_RefShrCross	0		Long term Refrigeration/Freezer Share/Efficiency Incremental Cross Price Elasticity
LT_DishShrCross	0		Long term Dishwasher Share/Efficiency Incremental Cross Price Elasticity
LT_CWashShrCross	0.01		Long term Clothes Washer Share/Efficiency Incremental Cross Price Elasticity
LT_DryShrCross	0.01		Long term Dryer Share/Efficiency Incremental Cross Price Elasticity
LT_TVShrCross	0		Long term TV Share/Efficiency Incremental Cross Price Elasticity
LT_FFShrCross	0		Long term Furnace Fan Share/Efficiency Incremental Cross Price Elasticity
LT_LightShrCross	0		Long term Light Share/Efficiency Incremental Cross Price Elasticity
LT_MiscShrCross	0		Long term Misc Share/Efficiency Incremental Cross Price Elasticity

20 YEAR (FY 1998-FY2017)		HDD	CDD		10 YEAR (FY 2006-FY2015)	HDD	CDD		20 YEAR (FY 2002-FY2021)			HDD	CDD
2018	1	*174.2*	*12.5*		1/1/2017	192.77	11.15		2023	10		159.2	9.0
2018	2	*153.0*	*17.4*		2/1/2017	166.22	16.28		2023	11		106.1	5.1
2018	3	*73.8*	*32.0*		3/1/2017	77.90	38.55		2023	12		102.9	30.5
2018	4	*23.4*	*96.6*		4/1/2017	19.83	108.42		2024	1		30.0	117.2
2018	5	*0.0*	*265.0*		5/1/2017	3.45	285.92		2024	2		2.6	253.4
2018	6	*0.0*	*451.8*		6/1/2017	0.30	446.21		2024	3		0.4	430.7
2018	7	*0.0*	*573.3*		7/1/2017	0.00	615.24		2024	4		0.0	583.5
2018	8	*0.0*	*668.8*		8/1/2017	0.00	651.47		2024	5		0.0	633.0
2018	9	*0.0*	*605.0*		9/1/2017	0.00	616.69		2024	6		0.0	597.2
2018	10	*0.0*	*331.8*		10/1/2017	0.21	319.25		2024	7		2.9	424.5
2018	11	*37.6*	*159.4*		11/1/2017	32.11	152.88		2024	8		19.8	129.5
2018	12	*80.2*	*20.2*		12/1/2017	94.44	32.76		2024	9		105.8	42.2
		542.3	**3233.8**			**587.2**	**3294.8**		**24285.0**	**78.0**		**529.6**	**3255.7**

ICA TC 2-9: Ref: ICA 1-3. This answer indicates that a 20 year historical period was used for normal weather in the weather model. Has AE compared the weather normalization result if a 10 year historical period is used instead of 20 years for normal? What is the comparison of total CDDs and HDDs for a 10 year normal annual period vs. the 20 year normal period used by AE?

ANSWER: Please refer to the discussion from Austin Energy's Technical Conference #2. The video recording of Technical Conference #2 may be found at: https://austintx.new.swagit.com/videos/174228

The following attachments were shown on screen:

Attachment ICA TC 2-8c

ICA TC 2-10: Provide the weather adjustment (kWh and revenue) by month compared to the actual revenue by month.

ANSWER: During the Technical Conference, Austin Energy answered that revenue is not part of the weather adjustment, but that the kWh requested was provided in the response to ICA 1-1. The ICA then asked for annual revenue, rather than monthly revenue, if that is available. Revenue impact is not quantified as part of Austin Energy's weather normalization process. However, the weather normalization of kWhs does affect the determination of present base revenues by altering the level of kWh billing units that are applied to current rates to calculate energy charge revenues under current rates. Given the tier structure, for the residential class it is not as straightforward to calculate the revenue impact of the weather normalization of kWh as it may be for a vertically integrated investor-owned utility (IOU) with a flat energy rate whose retail rates are regulated by the Public Utility Commission of Texas.

ICA TC 2-11: Ref: ICA 1-5. Explain whether an adjustment was made to current revenue to exclude the impact of the $10 credit for winter storm Uri.

ANSWER: The two zip codes were chosen based on relative demographic characteristics and presented for illustrative purposes only. An analysis was not conducted for all other zip codes.

ICA TC 2-15 (a) What is the basis for the classification of CIAC? Does the classification track AE's records regarding the types of facilities for which a developer contribution was made? Please explain how developers' contributions are used to reduce plant cost in the cost of service study. (b) Is the developer contribution primarily limited to services and meter, or does it include payment for additional load placed on upstream facilities (conductors, feeders, transformers, substations).

ANSWER: Austin Energy addressed subpart (a) during the Technical Conference, but follows up regarding subpart (b) here.

Austin Energy's Design Criteria Manual, section 1.3.12 AE Line Extension Policy states:

In accordance with Austin City Council Resolution No. 20140612-057, Austin Energy collects 100% of the costs for line extensions and new infrastructure associated with requests for new electric service, with an exemption for certain affordable housing. A Customer applying for new service will be charged all estimated costs for labor and material required to modify existing infrastructure and to extend service from Austin Energy's existing infrastructure to the Customer's point of service to serve the requested load, sometimes referred to as "Contributions in Aid of Construction," or "CIAC." This includes the service drop and meter.

ICA TC 2-18: With regard to AE's response to ICA 2-3: Provide the percentages based on revenues net of power supply costs, as shown on Appendix C, Page C-69.

<u>ANSWER:</u> See table below.

Fiscal Year	GFT % of Total operating revenue net of Power Supply & District Cooling
2019	11.9%
2020	12.0%
2021	12.4%
2022	11.8%

ICA TC 2-19: With regard to AE's response to ICA 2-5: For how many years are the $8 million per year expected to continue?

ANSWER: Given the magnitude of the eventual costs, Austin Energy expects to continue to set aside $8 million annually towards this obligation for the foreseeable future (and, at a minimum, for the next five years). Austin Energy had a non-nuclear decommissioning study performed in 2015 (see Attachment ICA RFI 2-5). Based on this study, in the 2016 Rate Review Austin Energy requested $19.4 million be set aside annually to fund this obligation (see table below from the 2016 RFP). However, at the conclusion of the 2016 Rate Review, Austin Energy was only allowed $8 million annually toward this obligation and has continued this level of funding since that time.

Work Paper D-1.2.5 in 2016 Rate Review

FERC Acct	Description	Reference	FY 2014	Decommission Costs (1)	Years to Amortize	Calculated Expense	Adjustment
			(A)	(B)	(C)	(D)	(E)
						(B) / (C)	(D) - (A)
506	Decker Units 1 and 2		$ -	$ 28,000,000	2	$ 14,000,000	$ 14,000,000
506	Fayette Power Plant		-	30,000,000	8	3,750,000	3,750,000
549	Sand Hill Energy Center		-	22,000,000	13	1,692,308	1,692,308
			$ -	$ 80,000,000		$ 19,442,308	$ 19,442,308

ICA TC 2-20: With regard to AE's response to ICA 2-6: Will the referenced correction remove the $4,662,375 non-cash adjustment to FY 2021? If not, please describe what the correction will entail.

<u>ANSWER:</u> Yes, the referenced correction will remove the non-cash adjustment.

ICA TC 2-21: With regard to AE's response to ICA 2-7: Explain the extent to which the increase in vegetation management is expected to be continuing in nature and why the increased spending is necessary.

- Attachment Page 2 – Is it appropriate to double the six months of spending to get an annualized level?
- Attachment Page 3 – Why does this page include more than twelve months of actual spending?

ANSWER: The increased level of vegetation management expense relative to the Test Year is expected to continue because it represents the implementation of a new, ongoing vegetation management program. In December 2020, the Austin City Council approved contracts to implement a new plan for vegetation management for both transmission and distribution lines by Austin Energy. However, the new plan could not be implemented immediately upon approval due to staffing and ramp-up challenges resulting from the COVID-19 pandemic. Winter Storm Uri and wildfire risk mitigation also played a role as many of the vegetation management crews supported power restoration efforts and efforts to remove brush in wildfire areas (in cooperation with other City departments).

The new vegetation management plan is necessary because it follows the City of Austin adopted guidelines for line clearances, limits on the amount of trimming that can be done in a single cycle, the protection of certain tree species, and Oak Wilt and Bird Habitat preservation restrictions. A new wildfire mitigation focus in conjunction with implementing industry recommended tree clearances also have delayed work management along overgrown circuits.

In reference to Attachment Page 2, the response is yes. Austin Energy initiated a new contract with Asplundh for vegetation management services to provide adequate clearances for transmission lines and towers. The contract began in September 2021, and only six months of actual spending data were available under the new contract at the time the base-rate filing package was developed. Please note that (a) this is the only contract for vegetation management for which only six months of actual spending data were available and an annualization adjustment was necessary, (b) the contract amount is small as a portion of Austin Energy's overall vegetation management spending, and (c) the services are for transmission lines and the expenses of the service are included in transmission FERC accounts which are part of Austin Energy's wholesale transmission cost of service and are outside the scope of this proceeding. Put differently, the annualization of the Asplundh contract for transmission lines has no impact on the retail base rates that are at issue in this proceeding. Austin Energy assigns the full amount of the Asplundh contract for transmission lines to the transmission function, and it is thus eliminated from the base-rate revenue requirement. For the workpapers that support the vegetation management expense in this proceeding, please see Austin Energy's response to Request No. ICA 2-7.

The adjustment on Page 3 of ICA Attachment ICA RFI 2-7: SD WP D_1_2_10 Vegetation Management K&M included 13 months of actual paid expenses, to recognize the ramp up of the program.

ICA TC 2-22: With regard to AE's response to ICA 2-8: Why are the increases in the budgeted heavy equipment lease expenses necessary? Are the amounts for FY 2023-2025 contractual obligations?

ANSWER: Please refer to Mark Dombroski's comments, starting at 1:22:40 of Austin Energy's Technical Conference #2. The video recording of Technical Conference #2 may be found at:
https://austintx.new.swagit.com/videos/174228

ICA TC 2-23: With regard to AE's response to ICA 2-9: Explain why the increase in staffing is necessary. With regard to Attachment ICA 2-9b, what are the present number of employees for each of the line items?

ANSWER: Please refer to Jerry Galvan's comments, starting at 1:24:10 of Austin Energy's Technical Conference #2. The video recording of Technical Conference #2 may be found at:
https://austintx.new.swagit.com/videos/174228

ICA TC 2-24: With regard to AE's response to ICA 2-11: Provide documentation supporting the contract at the Fayette Power Project associated with a federal tax credit that expired December 31, 2021 and the amount of $3,731,532. Why does Austin Energy not expect to collect payment on the disputed bill for pole attachments?

ANSWER: The termination of the contract is associated with the expiration of the Refined Coal Production Tax Credit on December 31, 2021. Austin Energy was not a direct party to the contract but benefited due to its participation in the Fayette Power Project.

The pole attachment issue concerns disputed infrastructure charges that were determined uncollectible.

Please refer to Monica Gonzalez's comments, starting at 1:25:00 of Austin Energy's Technical Conference #2. The video recording of Technical Conference #2 may be found at:
https://austintx.new.swagit.com/videos/174228

ICA TC 2-25: With regard to AE's response to ICA 2-13: To further clarify, provide budgeted Base Revenue under Current Rates reflecting Fiscal Year 2022 billing determinants, with supporting documentation.

ANSWER: For the Fiscal Year 21-22 budget, please refer to this link: FY22_Approved_Budget.pdf (austintexas.gov)

Page 377 reports budgeted base revenues of $629,480,229.

For the Fiscal Year 20-21 budget, please refer to this link: https://assets.austintexas.gov/budget/20-21/downloads/2020-21_Approved_Budget.pdf

Page 407 reports budgeted base revenues of $630,532,538.

Austin Energy's Responses to Questions from
Texas Industrial Energy Consumers (TIEC)

TIEC TC 2-1A: In its response to TIEC TC 1-2, Austin Energy stated that customers in the Primary Voltage Over 3 MW and Over 20 MW classes take delivery service directly from Austin Energy-owned distribution substations: Confirm that all of the Primary Voltage Over 20 MW customers are served directly from Austin Energy owned distribution substations. If not confirmed, list the customers who are not served directly from Austin Energy owned distribution substations.

ANSWER: Confirmed.

TIEC TC 2-1B: In its response to TIEC TC 1-2, Austin Energy stated that customers in the Primary Voltage Over 3 MW and Over 20 MW classes take delivery service directly from Austin Energy-owned distribution substations: Confirm that all of the Primary Voltage Over 3 MW and less than 20 MW customers are served directly from Austin Energy owned distribution substations. If not confirmed, list the customers who are not served directly from Austin Energy owned distribution substations.

ANSWER: Not confirmed.

<u>Austin Energy's Responses to Questions from 2WR</u>

2WR TC 2-1: Please walk me through how revenues from the CAP program were included in the rate-filing package, if any, to offset the base rate costs AE otherwise would have recovered in the customer charge and base rates but for the waiver of the customer charges and rate discounts for CAP customers.

<u>ANSWER:</u> This request was addressed during the Technical Conference.

2WR TC 2-2: Please explain how AE's treatment of CIAC in its rate-filing package ensures the proposed rates and rate designs do not include the costs of growth.

a) Has AE capitalized any of the infrastructure it constructed caused by growth?
b) If so, is any of the capitalized infrastructure included in the rate-filing package? Please identify where in the rate-filing package
c) Has AE incurred financing costs related to infrastructure caused by growth since 2014? If so, please detail the financing costs by year to the present. And if so, identify where AE has included these financing costs in the rate-filing package.
d) Has AE included any of the infrastructure it constructed caused by growth in its cost of service for purposes of allocating those costs among the customer classes? If so, please explain how they were used and identify the locations in the rate-filing package where they were addressed?
e) Please walk me through how AE installs a meter and initiates service to a new residential customer at a location with no distribution infrastructure to the house. Please identify the costs and business practices related to initiating service and providing this service to a new customer.
f) Please walk me through how AE initiates service to a new, non-real estate, large commercial customer at a location with no distribution infrastructure. Please identify the costs and business practices related to initiating service and providing this service to a new customer.
g) Please walk me through how AE initiates service to a new residential development customer for a new residential housing development project at a location with no distribution infrastructure. Please identify the costs and business practices related to initiating service and providing this service to a new customer.
h) Please list the infrastructure components AE referred to at page 8 of its rate-filing package that were incurred since 2014 to meet growth. For each of these components, please identify where they are addressed in the rate-filing package and state whether any of the costs incurred for that component are reimbursed through CIAC and if so, the amount reimbursed through CIAC.

<u>ANSWER:</u> Austin Energy does not track the reasons for capital projects, so Austin Energy does not know which (or what portion of) projects are related to growth, system reliability, renewals, replacements, or other causes.

However, the requirements for customer contributions for connection may be instructive. Austin Energy's Design Criteria Manual, section 1.3.12 AE Line Extension Policy states:

In accordance with Austin City Council Resolution No. 20140612-057, Austin Energy collects 100% of the costs for line extensions and new infrastructure associated with requests for new electric service, with an exemption for certain affordable housing. A Customer applying for new service will be charged all estimated costs for labor and material required to modify existing infrastructure and to extend service from Austin Energy's existing infrastructure to the Customer's point of service to serve the requested load, sometimes referred to as "Contributions in Aid of Construction," or "CIAC." This includes the service drop and meter.

This policy was put in place in 2014 and customers or developers requesting electric service to a new premise have paid the cost of connecting that premise to Austin Energy's electrical distribution system since that time. This policy is sometimes framed as "growth paying for growth." However, there are other impacts to Austin Energy when new customers and new load are added to the system, which are not included in Austin Energy's Line Extension Policy. Examples include:

- Increasing capacity on feeders that reach capacity with the addition of new load;
- Building new substations to distribute power to a greater number of circuits and feeders;
- Adding staff to operate and maintain the infrastructure and to provide customer service to the new customers; and
- Increasing indirect costs of added infrastructure and customers such as accounting, IT support, HR support, facilities, General Fund Transfer, and franchise payments for non-City of Austin customers.

A. As previously mentioned, Austin Energy does not categorize whether infrastructure investments are caused by growth. Regardless, infrastructure costs are, typically, capitalized and depreciated over time. An unidentified portion of these investments are caused by growth.

B. All capitalized infrastructure, through FY 2021, is included in the Base Rate Filing Package. Please see Work Papers B-1, B-2, B-3 for Original Cost of Plant, Work Paper B-5 for Accumulated Depreciation, and Work Paper E-1 for Depreciation Expense by FERC account.

The debt service associated with Austin Energy's capital investment is included in the Rate Filing Package (see Schedule C-3). Further, Schedule C-3 also demonstrates the entire CIAC funding ($43.6 million) is used to reduce the revenue requirement by offsetting the internally generated funds for construction (i.e., cash-funding needs).

C. As previously mentioned, Austin Energy does not track which (or what portion of) capital projects are related to growth versus system reliability, renewals, replacements, or other causes. However, all debt service is identified in Schedule C-3.

D. Some unspecified amount of infrastructure investments could be associated with growth. For the locations in the rate filing package where these infrastructure costs would appear, see the response to 2WR TC 2-2b.

E. See Austin Energy Design Criteria Manual (see link below). Section 1.4.2 describes the steps to obtain a new electric service, including meter installation requirements. The costs for obtaining service is covered the Line Extension Policy (1.3.12).

https://austinenergy.com/ae/contractors/electric-service-design-and-planning

F. The steps for a customer to obtain service, including non-residential service, is described in detail in the Austin Energy Design Criteria Manual. The work flow for services over 350 Amp Single-Phase or 225 Amp Three-Phase is shown on page 19 of the manual.

G. The steps for a customer to obtain service, including new residential developments, is described in the Austin Energy Design Criteria Manual. The work flow for services under 350 Amp Single-Phase or 225 Amps Three-Phase is shown on page 17 of the manual.

H. Please see responses to 2WR TC 2-2a, 2WR TC 2-2b and 2WR TC 2-2d. The table below includes CIAC between FY 2015 and FY 2021.

FY	**CIAC ($ thousands)**
2021	41,399
2020	43,908
2019	45,577
2018	34,986
2017	43,981
2016	40,862
2015	23,151

2WR TC 2-3: Please provide all affordability studies addressing, in whole or in part the Austin and AE service areas, prepared by or for, or that have been provided to AE; reviewed and/or relied upon by AE for this rate case; or are in AE's possession care, or control that have been issued or prepared since the last AE base rate review.

ANSWER: No. However, see the related study listed below.

"Assessment of Feasibility and Cost-Effectiveness of New and Expanded Energy Efficiency Programs in Response to Council Resolution 20160811-033 January 20, 2017"

https://austinenergy.com/wcm/connect/51f9b45b-4369-4b51-b3b7-52eec6d1810e/AssessmentFeasibilityCost-EffectivenessNewExpandedEnergy.pdf?MOD=AJPERES&CVID=mNOYdXA

2WR TC 2-4: How did AE account for the kWh self-generated by AE's residential customers who participated in the solar program in this rate case?

ANSWER: The energy generated by residential solar customers is included in the test year and rate year energy shown in WP H-5.1.

2WR TC 2-5: How did AE's residential customer solar program affect AEs reported revenues in this case?

ANSWER: There is no impact to the reported revenue. Under Austin Energy's "buy-all/sell-all" construct for solar customers, the customer is billed for the gross energy consumed on the premise (regardless of whether this energy is provided by Austin Energy or a photovoltaic system).

2WR TC 2-6: AE's power point presentation to the community about the base rate review at p.21 shows about a thirty percent increase in the number of bills issued where the underlying usage is 250kWh or less a month from 2009 to FY 2021. What does AE attribute this increase in bills at this level of usage? In your explanation address whether partial bills are a factor in this growth and whether the shifting housing stock to increasingly more apartments has led to increasing partial bills.

ANSWER: The increase in the number of bills with low usage is attributed to a number of different factors. The factors identified by Austin Energy are described in the Base Rate Filing Package, and include energy efficiency program participation, adoption of building codes requiring high energy performance, changes in the housing mix towards multi-family housing type, and demand response programs. For example, as stated in the Base Rate Filing Package (RFP) (page 79), " . . . Austin Energy has achieved a significant level of energy efficiency through targeted programs, in addition to gains from more efficient appliances and building codes." Additionally, on page 81, the RFP states ". . . part of the decline in residential consumption is due to changes in the housing mix. In 2009, the dominant housing type was single-family."

It is unknown if the proportion of partial bills in FY 2021 is significantly different from the proportion of bills in FY 2009, or during any intervening year. Austin Energy defines a partial bill as a bill with a billing period less than a full cycle (most billing cycles include at least 29 days; for this response, a partial bill would include any bill with less than 29 days). The number of partial bills during FY 2021, FY 2009, or any other year, is unknown.

2WR TC 2-7: How has AE addressed customer growth in its billing frequency analyses, in its bill impacts analyses, and in its billed revenues, if at all?

ANSWER: The shift in bill frequency to lower usage is addressed in the proposed residential rate design. The bill frequency analyses presented in Chapter 7 of the Base Rate Filing Package are stated as normalized proportions of bills, which eliminates the effects of customer growth on bill counts. With respect to bill impacts analyses, Austin Energy has not made any adjustments to the analyses to address customer growth, and it is difficult to envision how customer growth would be addressed in a bill impact analysis. With respect to billed revenues, customer growth is addressed by increasing billing units and therefore billed revenues.

2WR TC 2-8: Please provide the number of new AE residential customers added to AE electric service operations for each year starting in 2009 and ending in 2021 actual and TY2021 adjusted for known and measurable changes.

ANSWER: A report of the number of new residential customers added each year has not been prepared. The number of residential customers between FY 2007 and FY 2019 is available online. See link below. Please note the number of customers represents the average number of customers by Fiscal Year.

https://data.austintexas.gov/Utilities-and-City-Services/Austin-Energy-Customer-Counts-by-Customer-Class/9xdm-yhmb

The average number of residential customers for FY 2020 and FY 2021 are as follows: FY 2020 was 454,616, and FY 2021 was 467,291.

With respect to adjustments, no adjustments to the year-end count of customers were performed.

2WR TC 2-9: Please explain how partial bills—those bills that represent service for less than the normal billing period—are addressed in your rate-filing package. In your explanation please include any studies or reports that have been prepared by or for, or provided to AE, or that have been reviewed by AE addressing partial billing.

<u>ANSWER:</u> As indicated in the response to 2WR TC 2-6, the number of partial bills was not determined for FY 2009 or FY 2021. It is unknown if the proportion of partial bills has changed over the time span between FY 2009 and FY 2021.