VOLUME 3

LOAD ANALYSIS AND LOAD FORECASTING

EVERGY METRO

INTEGRATED RESOURCE PLAN

4 CSR 240-22.030

APRIL 2021

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HIGHLIGHTS

- Evergy Metro expects energy consumption to grow 0.65% and peak demand to grow 0.56% annually from 2020-2040.
- Residential energy consumption is expected to provide the most growth over the next 20 years.
- Evergy Metro customers are expected to grow 0.4% annually from 2020-2040.
- Key forecast uncertainties include the impact of rising prices, technological advancement in renewable energy sector, adoption of new consumer products and energy efficiency.

PURPOSE: This rule sets minimum standards for the maintenance and updating of historical data, the level of detail required in analyzing loads, and the purposes to be accomplished by load analysis and by load forecast models. The load analysis discussed in this rule is intended to support both demand-side management efforts of 4 CSR 240-22.050 and the load forecast models of this rule. This rule also sets the minimum standards for the documentation of the inputs, components, and methods used to derive the load forecasts.

SECTION 1: SELECTING LOAD ANALYSIS METHODS

The utility may choose multiple methods of load analysis if it deems doing so is necessary to achieve all of the purposes of load analysis and if the methods are consistent with, and calibrated to, one another. The utility shall describe and document its intended purposes for load analysis methods, why the selected load analysis methods best fulfill those purposes, and how the load analysis methods are consistent with one another and with the endues consumption data used in the demand-side analysis as described in 4 CSR 240-22.050. At a minimum, the load analysis methods shall be selected to achieve the following purposes:

1.1 PURPOSE: IDENTIFICATION OF END-USE MEASURES

(A) To identify end-use measures that may be potential demand-side resources, generally, those end-use measures with an opportunity for energy and/or demand savings;

1.2 PURPOSE: DERIVATION OF DATA SET OF HISTORICAL VALUES

(B) To derive a data set of historical values from load research data that can be used as dependent and independent variables in the load forecasts;

1.3 PURPOSE: ANALYSIS OF IMPACTS OF IMPLEMENTED DSM AND DEMAND-SIDE RATES ON LOAD FORECASTS

(C) To facilitate the analysis of impacts of implemented demand-side programs and demand-side rates on the load forecasts and to augment measurement of the effectiveness of demand-side resources necessary for 4 CSR 240-22.070(8) in the evaluation of the performance of the demand-side programs or rates after they are implemented; and

1.4 PURPOSE: PRESERVATION OF LOAD ANALYSIS IN HISTORICAL DATABASE

(D) To preserve, in a historical database, the results of the load analysis used to perform the demand-side analysis as described in 4 CSR 240-22.050, and the load forecasting described in 4 CSR 240-22.030.

SECTION 2: HISTORICAL DATABASE FOR LOAD ANALYSIS

The utility shall develop and maintain data on the actual historical patterns of energy usage within its service territory. The following information shall be maintained and updated on an ongoing basis and described and documented in the triennial compliance filings:

2.1 CUSTOMER CLASS DETAIL

(A) Customer Class Detail. At a minimum, the historical database shall be maintained for each of the major classes;

Evergy Metro maintains a historical database of its loads for each major class, which are Residential, Small General Service (SGS), Medium General Service (MGS), Large General Service (LGS), Large Power (LP), Lighting and Sales for Resale (SFR). In addition, SGS, MGS, LGS and LP are split into the subclasses commercial and industrial. This data begins in May 2005 for Evergy Metro and will be maintained with at least 10 years of history going forward. Beginning with the 2015 IRP filling, Evergy Metro forecasts its loads for each major class, which are Residential, Commercial Small General Service (SGS), Commercial Big (The sum of MGS, LGS, and LP), Industrial (The sum of SGS, MGS, LGS, and LP), Lighting, and Sales for Resale (SFR).

2.2 LOAD DATA DETAIL

(B) The historical load database shall contain the following data:

2.2.1 ACTUAL AND WEATHER NORMALIZED ENERGY, AND NUMBER OF CUSTOMERS

1. For each jurisdiction for which it prepares customer and energy and demand forecasts, for each major class, to the actual monthly energy usage and number of customers and weather-normalized monthly energy usage;

MetrixND files are used to maintain this data for each subclass listed in 22.030 (2) (A). These files also contain the models used to forecast the number of customers and weather-normalize and forecast monthly energy sales.

2.2.2 ACTUAL AND WEATHER NORMALIZED DEMANDS

2. For each jurisdiction and major class, estimated actual and weather-normalized demands at the time of monthly system peaks; and

Actual and weather-normalized coincident demands are provided in Appendix 3B and MetrixLT projects MetroMO_ClassEndUse.ltm, MetroMO_ClassEndUseWN.ltm, MetroKS_ClassEndUse.ltm and MetroKS_ClassEndUseWN.ltm. This data is available beginning in May 2005 at which time the load research sample converted from revenue class to Class Cost of Service (CCOS). Class level hourly loads are currently weather normalized when a rate case is prepared. Jurisdiction level peaks are weather normalized annually when forecasting peak demand for the triennial IRP or IRP update.

2.2.3 ACTUAL AND WEATHER NORMALIZED SYSTEM PEAK DEMANDS

3. For the system, actual and weather normalized hourly net system load;

Actual and weather-normalized Net System Input (NSI) is contained in the MetrixLT files.

2.3 LOAD COMPONENT DETAIL

(C) The historical database for major class monthly energy usage and demands at time of monthly peaks shall be disaggregated into a number-of-units component and a use-per-unit component, for both actual and weather-normalized loads.

2.3.1 UNITS COMPONENT

1. The number-of-units component shall be the number of customers, square feet, devices, or other units as appropriate to the customer class and the load analysis method selected by the utility. The utility shall select the units component with the intent of providing meaningful load analysis for demand-side analysis and maintaining the integrity of the database over time.

The number-of-units is the number of customers for residential and SGS commercial. For the other subclasses, MWh sales are modeled because it is more stable than kWh sales per customer and the model fit statistics are higher. In the big commercial and Industrial customer classes, the size of customers varies more than in the smaller classes and use per customer can vary substantially as customers enter or exit the class.

2.3.2 UPDATE PROCEDURE

2. The utility shall develop and implement a procedure to routinely measure and regularly update estimates of the effect of departures from normal weather on class and system electric loads. The estimates of the effect of weather on historical major class and system loads shall incorporate the nonlinear response of loads to daily weather and seasonal variations in loads.

Evergy Metro has developed a MetrixND model for each subclass of kWh sales that weather normalizes sales or sales per unit. These models will update weather normalized sales at the subclass level whenever these models are updated. This procedure is automatic. Major class level demands are currently weather normalized only for a rate case and this process is not automatic as it requires many manual steps. Heating and cooling degree days calculated with different base temperatures were tested and kept in the models if statistically significant so that nonlinear weather response functions could be represented.

2.3.3 WEATHER MEASURES AND ESTIMATION OF WEATHER EFFECTS DESCRIPTION AND DOCUMENTATION

3. The utility shall describe and document the methods used to develop weather measures and the methods used to estimate the effect of weather on electric loads. If statistical models are used, the documentation shall include at least: the functional form of the models; the estimation techniques employed; and the relevant statistical results of the models, including parameter estimates and tests of statistical significance. The data used to estimate the models, including the development of model input data from basic data, shall be included in the workpapers supplied at the time the compliance report is filed;

In this IRP filing, Evergy Metro used different methods to model the effects of weather for normalization and for forecasting. One reason for using different methods is that the sample period for WN needed to cover the entire period that historical data was available so that data could be WN. On the other hand, the forecasting models often need a more recent shorter sample period since the focus is on calibrating an end-use forecast to recent data. The method of WN used in this IRP filing is different than that used in the rate cases because it is designed to WN many years of data whereas the rate case models are based on only two years of data. Also, the method used here is much less labor intensive and can be updated more routinely.

Degree days computed at different base temperatures were tested in explaining the effects of weather on sales and system load. Degree days computed with more than one base temperature were tested in the same model to determine if the load response is nonlinear. The statistical results of model estimation in the weather normalization models of monthly sales are presented in this section. Additional information is available in the MetrixND model files that are included in the electronic workpapers. This additional information includes formulas that define the explanatory variables, plots and tables of residuals, plots and tables of actual, weather-normalized and predicted values, plots and tables of explanatory variables and model statistics and coefficients. The model coefficients were estimated using ordinary least squares regression in MetrixND. The estimation period for each class may be different, but generally includes the time period from January 2009 to December 2019.

Table 1: WN Model for MO Metro Residential Sales

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	20.766	0.745	27.865	0.00%
mWthrRevPD.HDD55	0.637	0.010	60.706	0.00%
mWthrRevPD.CDD65	1.618	0.051	31.884	0.00%
mWthrRevPD.CDD75	0.326	0.133	2.460	1.53%
mBin.Feb	-0.739	0.254	-2.912	0.43%
mBin.Jun	-1.518	0.241	-6.286	0.00%
mBin.Nov	-0.857	0.248	-3.460	0.08%
mBin.Jul12	-2.282	0.791	-2.885	0.46%
ResAvgUsePD.Nov09	2.154	0.741	2.908	0.43%
ResAvgUsePD.BeforeMay18	1.278	0.206	6.210	0.00%
ResAvgUsePD.CCBCalib	-0.194	0.025	-7.800	0.00%

Table 2: WN Model for MO Metro Small GS Commercial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	26.030	2.621	9.932	0.00%
mWthrRevPD.HDD50	0.571	0.025	23.110	0.00%
mWthrRevPD.CDD65	1.301	0.037	35.317	0.00%
ComSmlAvgUsePD.Dec11toDec14	-1.576	0.321	-4.914	0.00%
ComSmlAvgUsePD.Jul09	4.007	1.578	2.540	1.24%
ComSmlAvgUsePD.Feb15	-4.595	1.559	-2.947	0.39%
ComSmlAvgUsePD.Jun17	-3.642	1.586	-2.296	2.34%
mBin.TrendAfterYr12	0.563	0.086	6.540	0.00%
ComSmlAvgUsePD.BeforeMay18	-4.818	0.595	-8.100	0.00%
ComSmlAvgUsePD.CalibCCB	-3.320	0.672	-4.937	0.00%
ComSmlAvgUsePD.CalibCov	-7.710	1.434	-5.378	0.00%
ComSmlAvgUsePD.Mar19	3.139	1.564	2.007	4.70%
mBin.Feb	1.950	0.545	3.580	0.05%
mBin.Jun	-2.303	0.520	-4.427	0.00%
mBin.Jul	-1.676	0.587	-2.857	0.50%
mBin.Oct	2.075	0.499	4.159	0.01%

Table 3: WN Model for MO Metro Big Commercial Sales (MGS, LGS and LP)

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	10843563.495	282340.955	38.406	0.00%
mWthrRevPD.HDD55	65042.754	2512.717	25.885	0.00%
mWthrRevPD.CDD60	161792.205	3900.039	41.485	0.00%
mBin.Mar	326988.334	53134.079	6.154	0.00%
mBin.May	187348.670	59249.720	3.162	0.20%
mBin.Aug	364358.104	72724.099	5.010	0.00%
mBin.Sep	268773.560	63651.072	4.223	0.01%
mBin.Oct	592181.417	58592.747	10.107	0.00%
ComBigSalesPD.Aug15	-523339.110	176555.900	-2.964	0.37%
ComBigSalesPD.Jun16	-407806.120	171174.107	-2.382	1.88%
ComBigSalesPD.Jul17	643810.085	175358.634	3.671	0.04%
ComBigSalesPD.Nov17	-1790087.756	171927.898	-10.412	0.00%
ComBigSalesPD.Jun18	-453105.156	175456.254	-2.582	1.10%
ComBigSalesPD.BeforeMay18	140357.004	62108.754	2.260	2.57%
mBin.TrendAfterYr12	-72345.791	9258.221	-7.814	0.00%
ComBigSalesPD.Jun19	-520527.233	173585.061	-2.999	0.33%
ComBigSalesPD.Feb19	592500.214	174777.888	3.390	0.10%
ComBigSalesPD.CalibCov	-1859693.390	161698.382	-11.501	0.00%
ComBigSalesPD.Aug19	-643772.122	180130.174	-3.574	0.05%
ComBigSalesPD.Sep19	819815.937	179330.973	4.572	0.00%

Table 4: WN Model for MO Metro Industrial Sales (SGS, MGS, LGS and LP)

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	4567005.991	259827.704	17.577	0.00%
mWthrRevPD.CDD60	31117.493	3987.787	7.803	0.00%
IndSalesPD.Feb09	-1540789.664	296404.963	-5.198	0.00%
IndSalesPD.Mar09	1478588.293	296096.509	4.994	0.00%
IndSalesPD.Feb10	-1357792.911	294729.775	-4.607	0.00%
IndSalesPD.Mar10	1939644.647	294604.570	6.584	0.00%
IndSalesPD.Jun09	-879894.785	295187.234	-2.981	0.36%
IndSalesPD.Jul09	737073.431	297155.515	2.480	1.47%
IndSalesPD.Dec15	-829812.316	292697.888	-2.835	0.55%
IndSalesPD.Nov17	2307799.812	294587.314	7.834	0.00%
mBin.TrendVar	-24417.331	10725.890	-2.276	2.49%

Table 5: WN Model for KS Metro Residential Sales

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	29.008	0.596	48.701	0.00%
mWthrRevPD.HDD50	0.160	0.054	2.998	0.33%
mWthrRevPD.HDD55_seas	0.537	0.047	11.305	0.00%
mWthrRevPD.CDD65	1.625	0.046	35.102	0.00%
mWthrRevPD.CDD60_seas	0.373	0.033	11.245	0.00%
mBin.TrendVar	-0.322	0.019	-16.607	0.00%
ResAvgUsePD.Jul08	2.524	0.630	4.009	0.01%
ResAvgUsePD.Sep09	-1.701	0.623	-2.731	0.72%
ResAvgUsePD.Dec09	1.835	0.627	2.925	0.41%
ResAvgUsePD.Feb10	1.599	0.630	2.540	1.23%
ResAvgUsePD.Jul11	3.998	0.628	6.364	0.00%
mBin.Aug12	-2.724	0.637	-4.276	0.00%
ResAvgUsePD.Dec15	1.460	0.628	2.324	2.17%
ResAvgUsePD.Jun16	1.925	0.628	3.064	0.27%
ResAvgUsePD.Sep17	1.775	0.625	2.839	0.53%
ResAvgUsePD.CCB	0.804	0.194	4.149	0.01%
ResAvgUsePD.Aug18	-2.480	0.639	-3.881	0.02%
ResAvgUsePD.Aug19	-1.903	0.639	-2.980	0.35%

Table 6: WN Model for KS Metro Small GS Commercial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	-14.472	2.090	-6.925	0.00%
mWthrRevPD.HDD55	0.412	0.018	22.402	0.00%
mWthrRevPD.CDD65	1.264	0.035	36.125	0.00%
mBin.TrendAfterYr12	2.002	0.090	22.358	0.00%
mBin.AfterYr12	-2.187	0.417	-5.250	0.00%
ComSmlAvgUsePD.Oct11	-3.057	1.599	-1.913	5.81%
ComSmlAvgUsePD.Oct13	-3.084	1.603	-1.924	5.66%
ComSmlAvgUsePD.CalibCCB	-1.665	0.641	-2.595	1.06%
ComSmlAvgUsePD.CalibCov	-7.408	1.204	-6.152	0.00%
ComSmlAvgUsePD.CalibSml	-2.617	0.435	-6.011	0.00%

Table 7: WN Model for KS Metro Big Commercial Sales (MGS and LGS)

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	6641900.400	47217.737	140.665	0.00%
mWthrRevPD.HDD55	47952.560	2494.209	19.226	0.00%
mWthrRevPD.CDD60	125257.055	3729.216	33.588	0.00%
ComBigSalesPD.BeforeApr13	-172233.480	38351.398	-4.491	0.00%
ComBigSalesPD.CalibCCB	135967.928	46400.559	2.930	0.41%
ComBigSalesPD.Jun18	-511565.125	113738.706	-4.498	0.00%
ComBigSalesPD.Aug18	287068.134	112574.735	2.550	1.21%
ComBigSalesPD.Sep18	-777488.069	112681.744	-6.900	0.00%
ComBigSalesPD.CalibCov	-964252.836	84547.779	-11.405	0.00%
SAR(1)	0.561	0.073	7.632	0.00%

Table 8: WN Model for KS Metro Industrial Sales (SGS, MGS and LGS)

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	1357929.291	124586.631	10.899	0.00%
mWthrRevPD.CDD60	8866.504	942.341	9.409	0.00%
IndSalesPD.Mar09	233055.323	36248.408	6.429	0.00%
IndSalesPD.Mar10	209330.227	36118.651	5.796	0.00%
mBin.TrendVar	-22785.966	5238.895	-4.349	0.00%
IndSalesPD.May18	-75196.832	36086.912	-2.084	3.93%
AR(1)	0.745	0.062	11.988	0.00%

2.4 ASSESSMENTS

(D) For each major class specified pursuant to subsection (2)(A), the utility shall provide, on a seasonal and annual basis for each year of the historical period—

For the current Evergy Metro filing, historical sales and customers broken out by class cost of service for residential and industrial customers were available beginning in January 2000. Commercial class cost of service data was available beginning May 2005. Going forward, Evergy Metro will maintain this data for at least the previous 10 years.

2.4.1 HISTORIC END-USE DRIVERS OF ENERGY USAGE AND PEAK DEMAND

1. Its assessment of the historical end-use drivers of energy usage and peak demand, including trends in numbers of units and energy consumption per unit;

Historical plots of customers and kwh/customer for energy usage and peak demand can be found in *Appendix 3A.*

Residential customer growth for Evergy Metro was 1% or higher during the late 1990s and the housing boom of the early 2000s. Beginning in 2007, customer growth slowed to below 1% and slow growth continued until growth in housing development began to occur in 2013. A catch-up effect has resulted in average customer growth of 1.1% for 2012-2019.

Evergy Metro SGS Commercial customer growth was flat (average of 0.2%) in the late 2000s and early 2010s, but has risen since 2012, largely due to customer migrations from other classes. Growth from 2012 to 2019 averaged 1.3%.

Commercial Big (MGS, LGS, LP) saw rapid customer growth in the late 2000s, averaging 2.4% from 2006 to 2010, but has been flat thereafter, averaging 0.0% since 2010. This is largely due to customers migrating to the small general service class such that all the commercial customer growth has been realized in the small class.

Industrial customers have gradually declined through the recent couple decades, averaging -1.3% growth since 2010.

Residential MWh use per customer reveal a downward trend in both summer usage (-0.7%) and non-summer (-1.1%) usage over the last decade following a period of modest growth in non-summer use per customer in the late 2000s. The downward trend in summer usage is due to increasing efficiency of air conditioning units. The downward trend in non-summer use per customer is due to increasing saturation of electric space heat offset by increasing efficiency of base load appliances such as refrigerators, lighting, computers, etc.

For Commercial SGS, both summer and non-summer use per customer declined through the year 2012. During the last decade, use per customer saw annual growth for both summer (1.8%) and non-summer (1.9%) due to the impact of customer migrations between classes.

Commercial Big (MGS, LGS, LP) use per customer declined prior to 2012 for both summer (-1.4%) and non-summer (-1.1%). Use per customer has been slightly negative for both summer (-0.2%) and non-summer (-0.4%) since 2012 as efficiency gains in end uses have continued, but have been offset by the impact of customer migrations between classes.

From 2005 to 2010 Industrial use per customer declined at an annual rate of -0.5% for summer and -0.5% for non-summer months. Since 2010 Industrial use per customer has been flat for both summer (0.1%) and non-summer (0.0%) on an annual basis, while customers and employment have steadily declined. This points to an increase in equipment use over labor use amongst area manufacturers.

2.4.2 WEATHER SENSITIVITY OF ENERGY AND PEAK DEMAND

2. Its assessment of the weather sensitivity of energy and peak demand.

The following plots illustrate the weather response function of daily energy and peak demand for each major class. This data is weather normalized in the rate case process during which the weather response function is represented with an equation estimated with statistical regression analysis for the time period of January 2014 through December 2018, with the exception for Metro KS Sales for Resale which has data through June 2017. The blue symbols in the plot represent weekdays and the red symbols represent weekends.

Figure 1: MO Metro Residential Daily Energy vs Average Temp

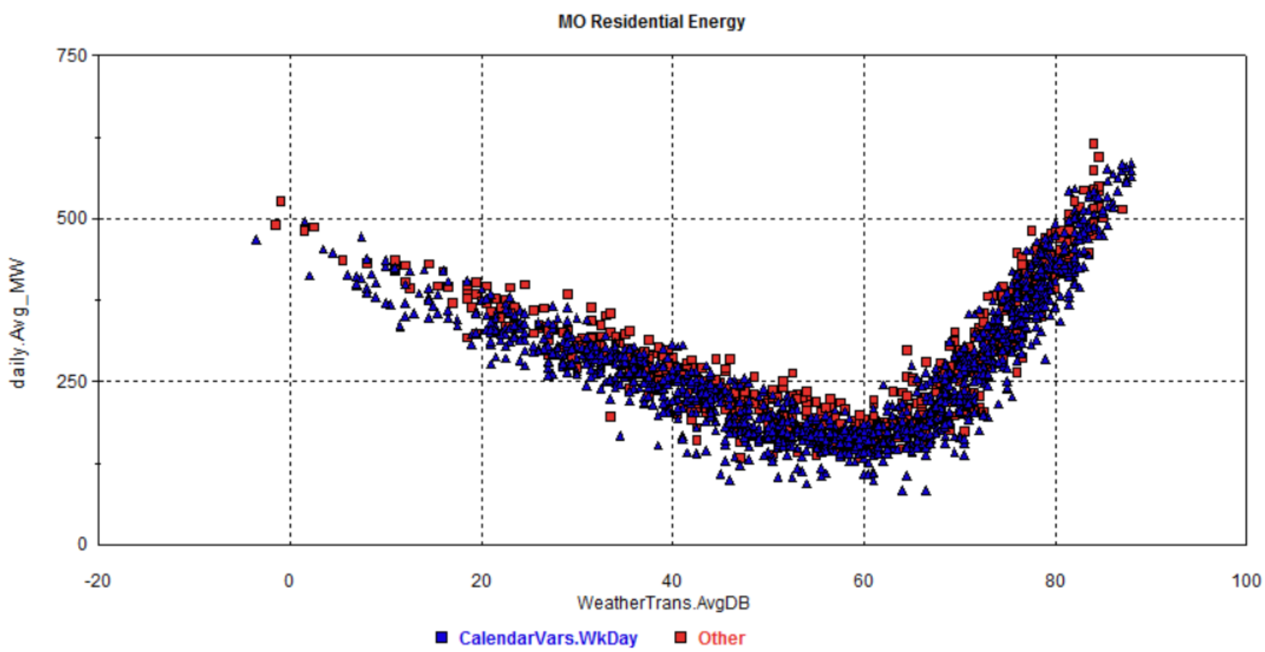


Figure 2: MO Metro Residential Daily Peak Demand vs Average Temp

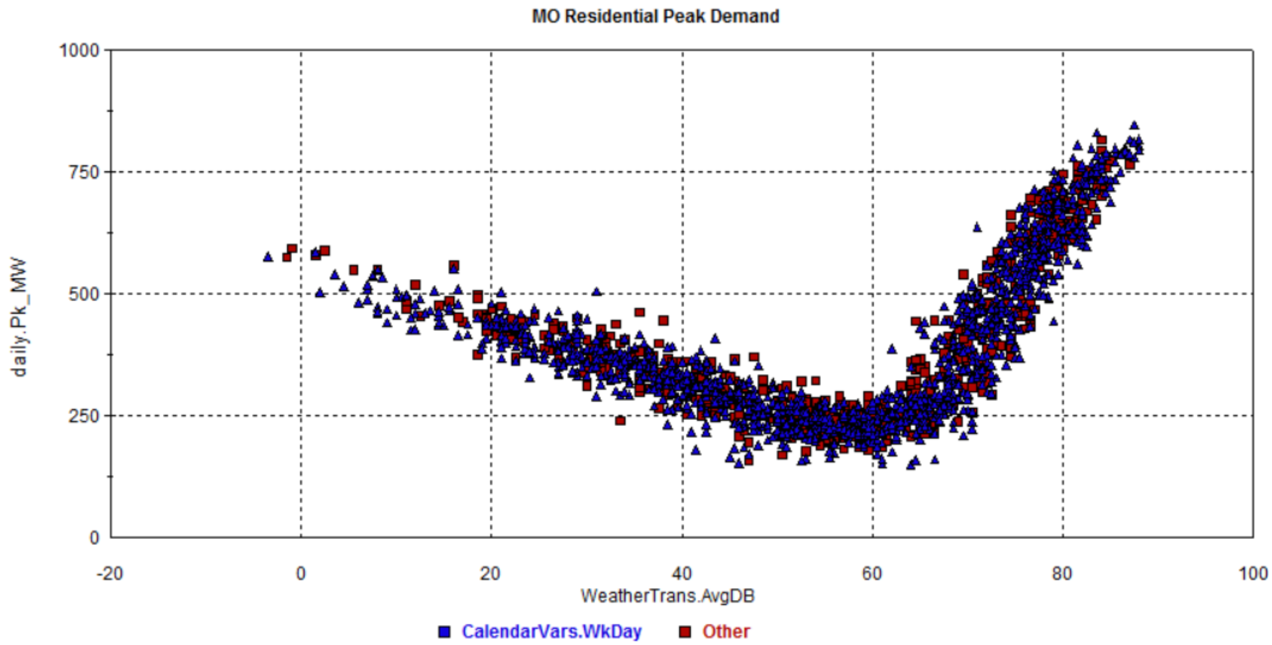


Figure 3: MO Metro Small General Service Daily Energy vs Average Temp

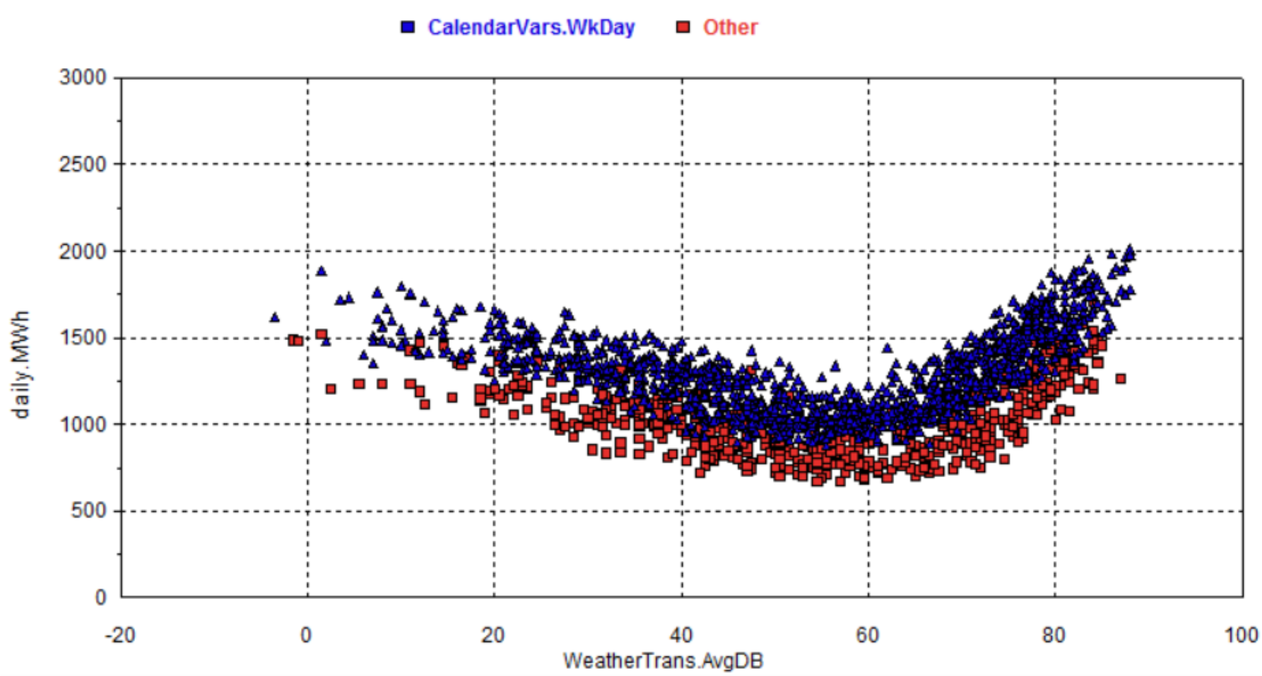


Figure 4: MO Metro Small General Service Daily Peak vs Average Temp

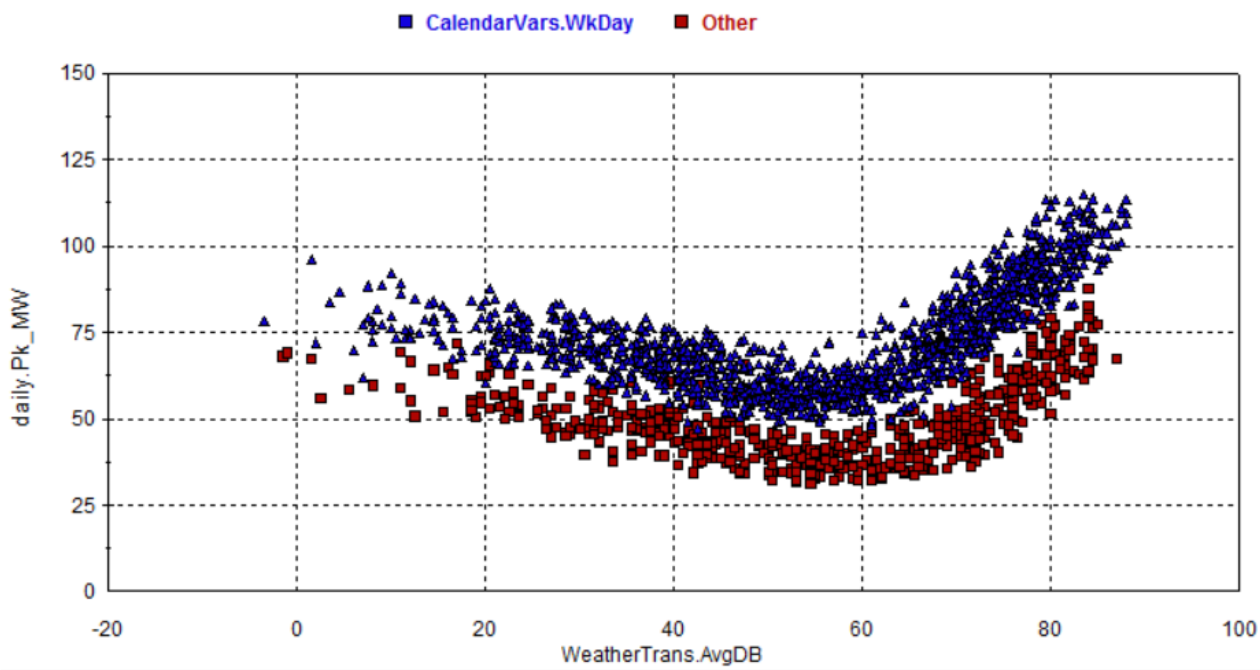


Figure 5: MO Metro Medium General Service Daily Energy vs Average Temp

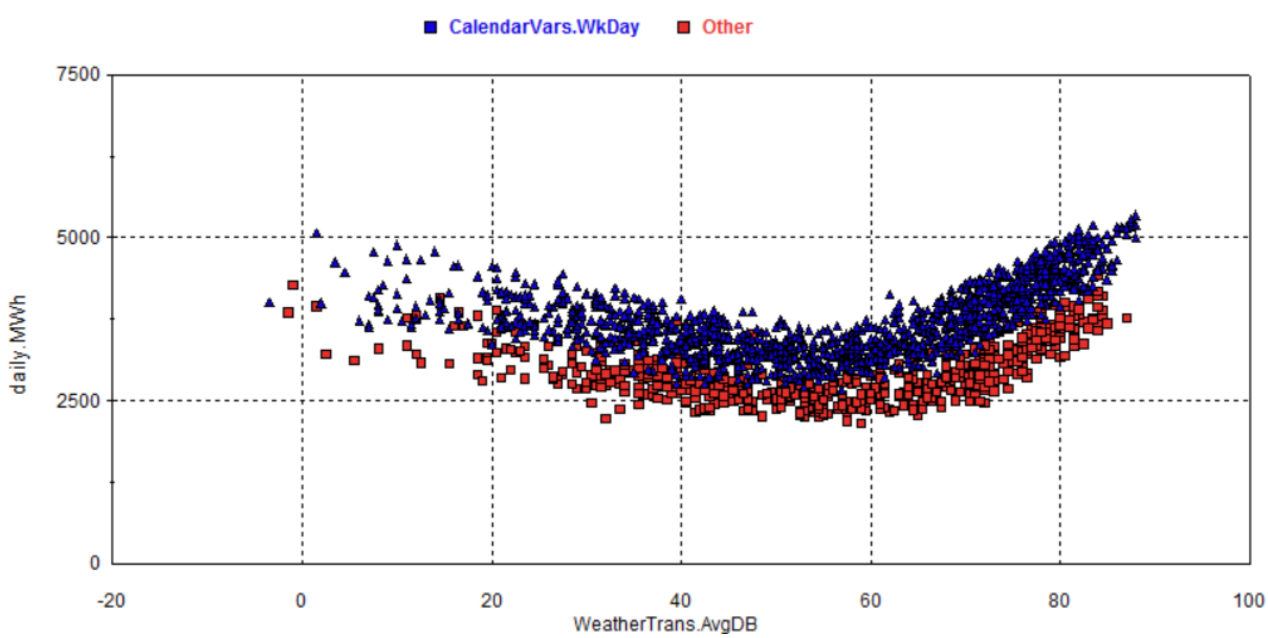


Figure 6: MO Metro Medium General Service Daily Peak Demand vs Average Temp

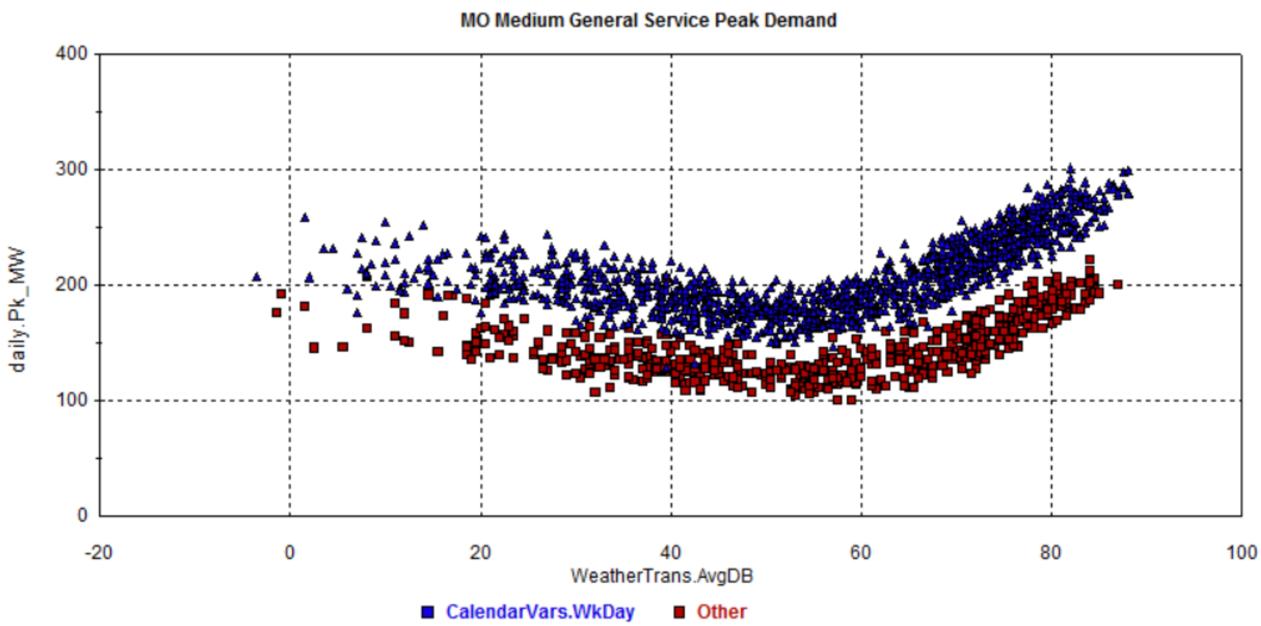


Figure 7: MO Metro Large General Service Daily Energy vs Average Temp

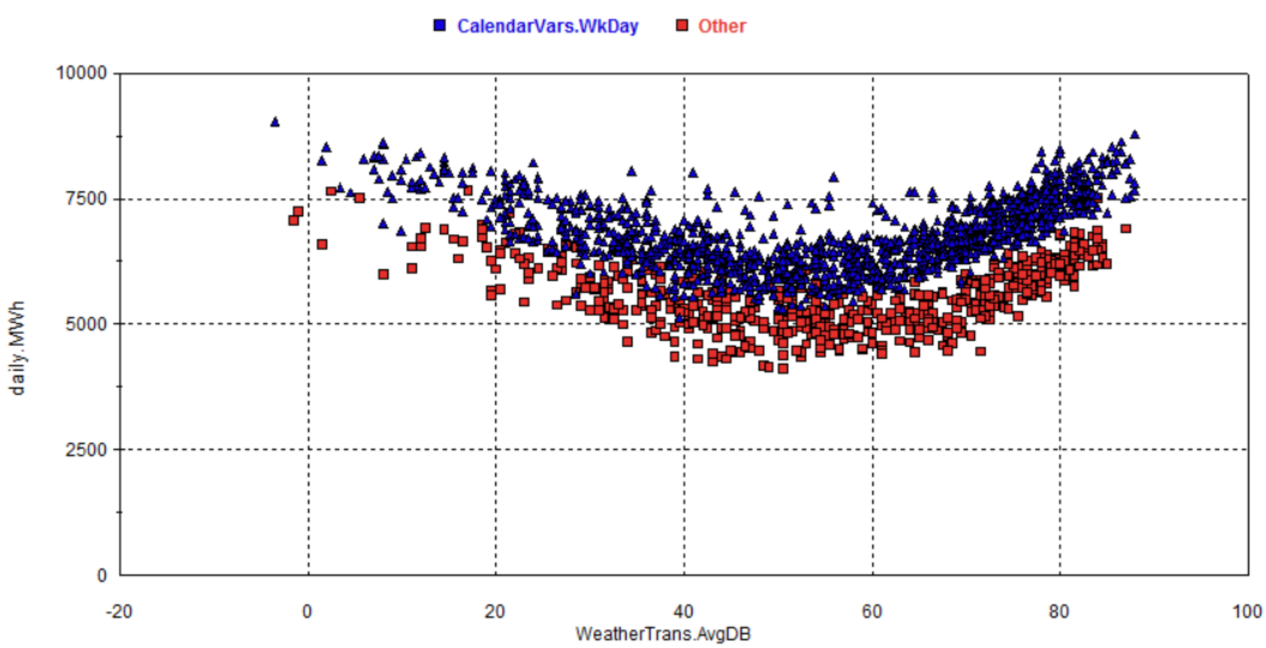


Figure 8: MO Metro Large General Service Daily Peak Demand vs Average Temp

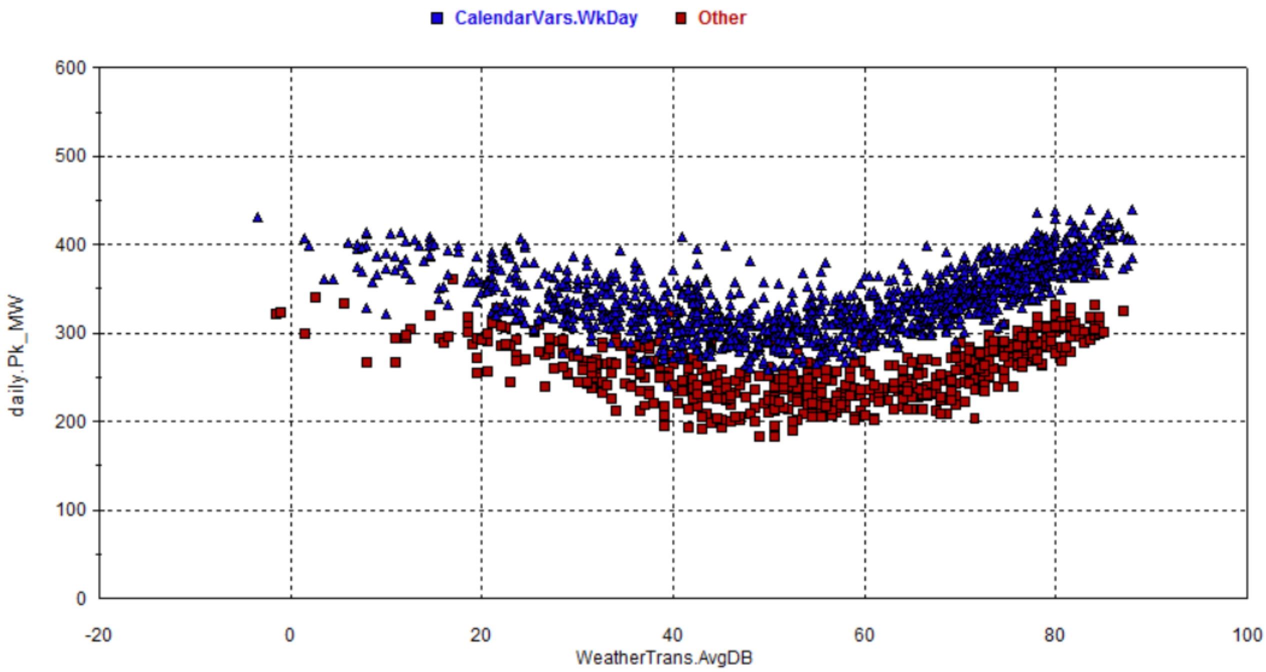


Figure 9: MO Metro Large Power Daily Energy vs Average Temp

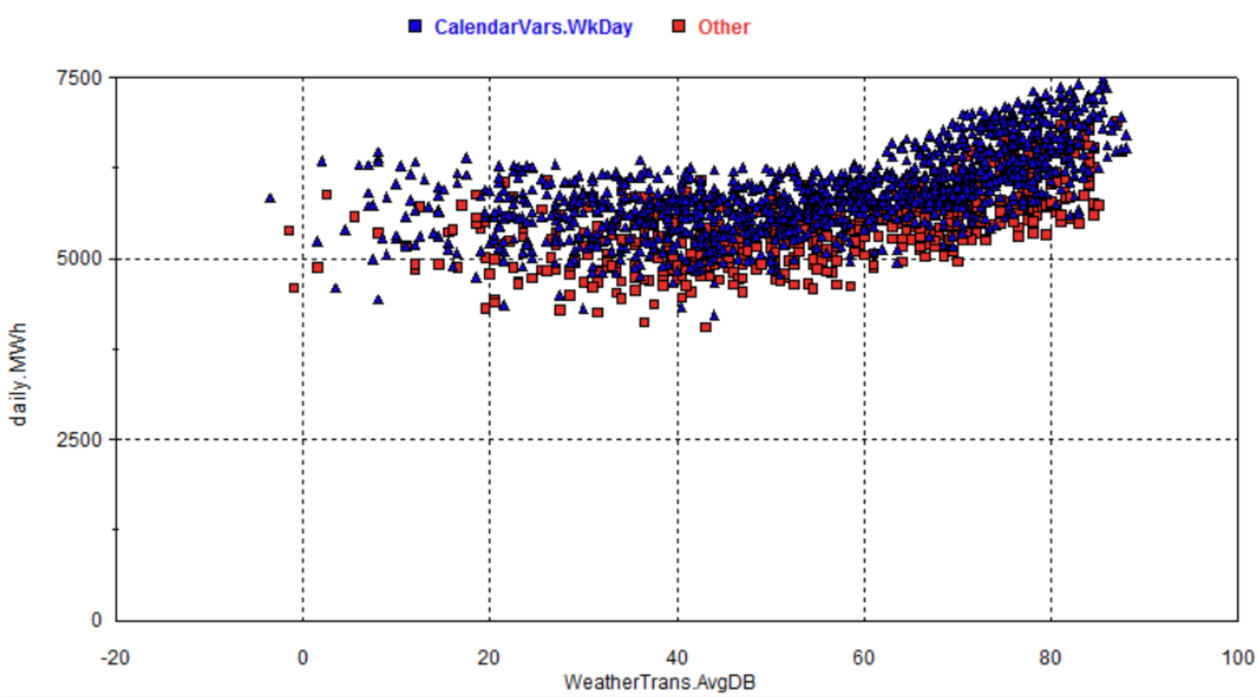


Figure 10: MO Metro Large Power Daily Peak Demand vs Average Temp

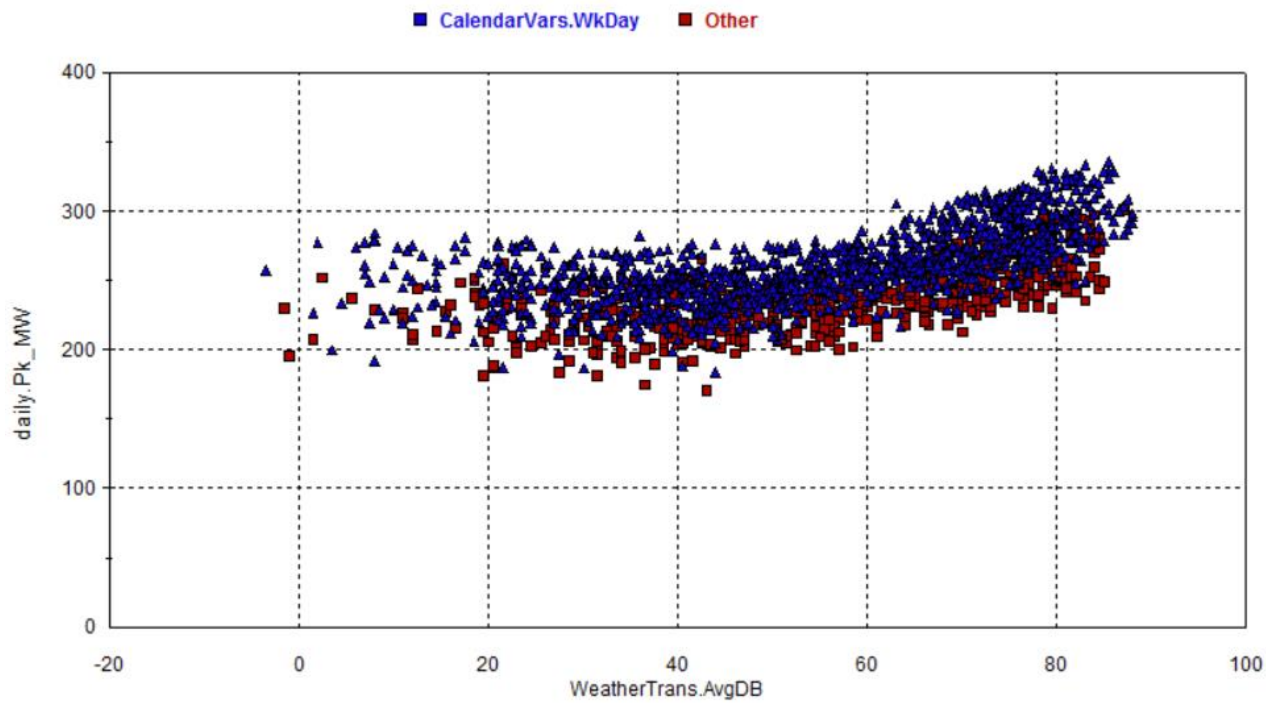


Figure 11: MO Metro Sales for Resale Daily Energy vs Average Temp

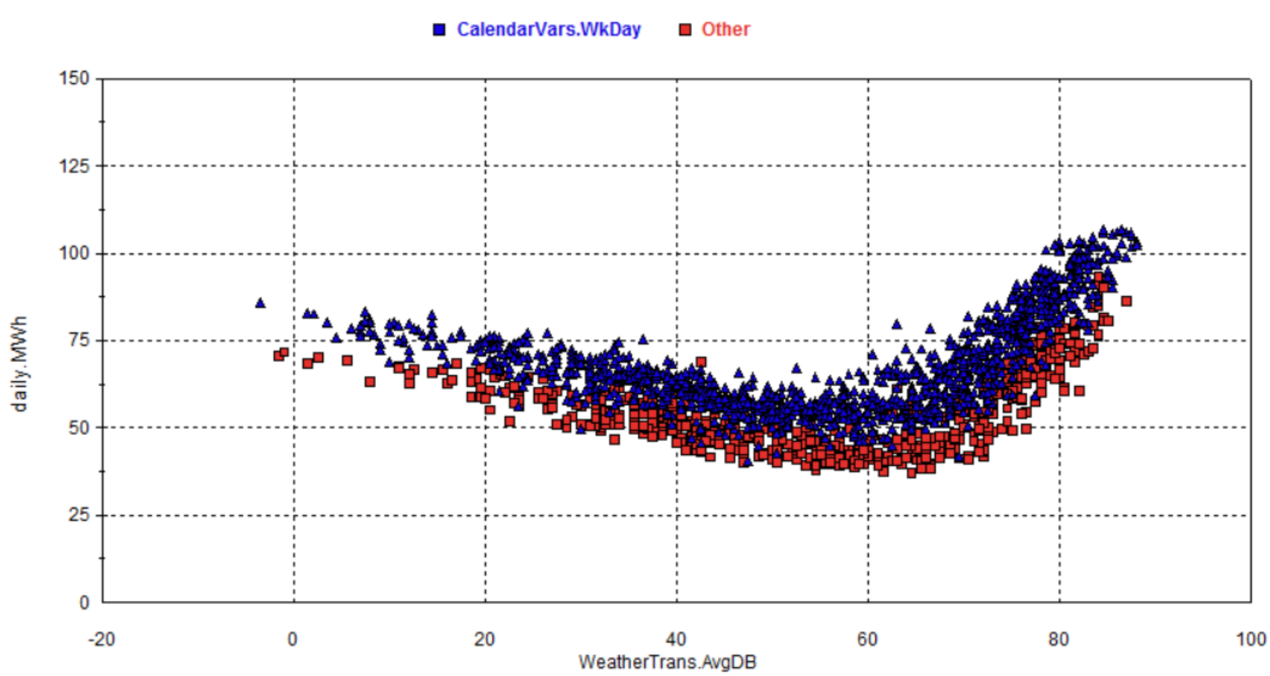


Figure 12: MO Metro Sales for Resale Daily Peak Demand vs Average Temp

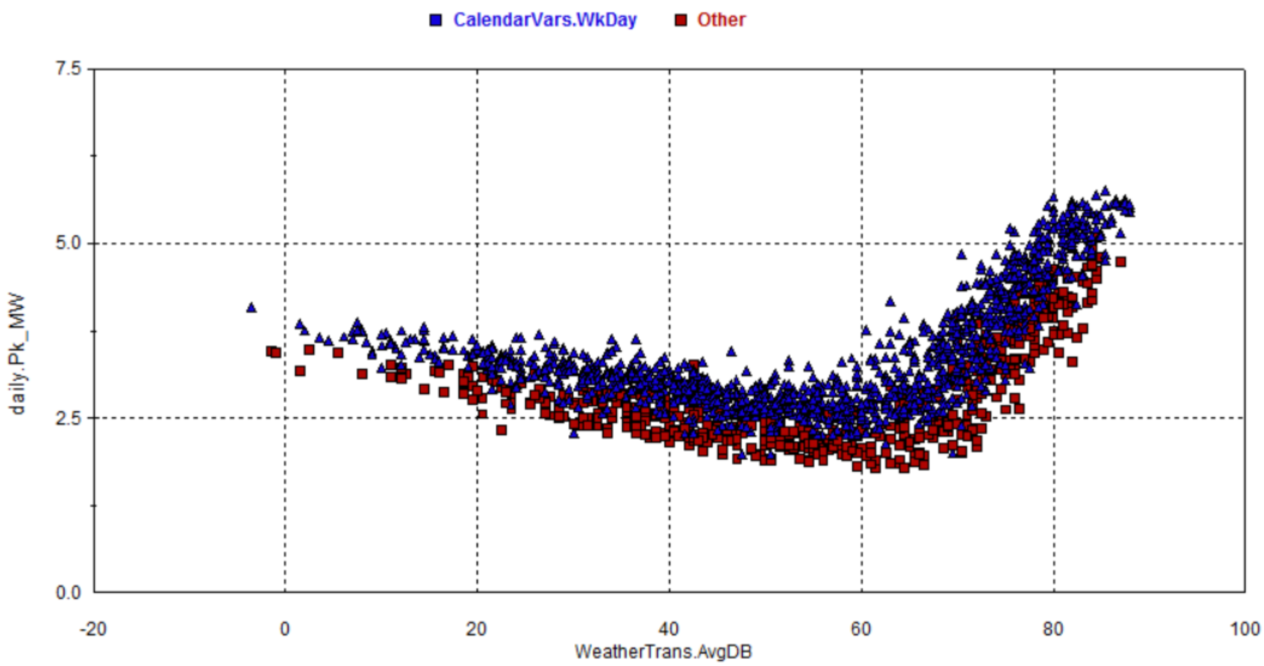


Figure 13: KS Metro Residential Daily Energy vs Average Temp

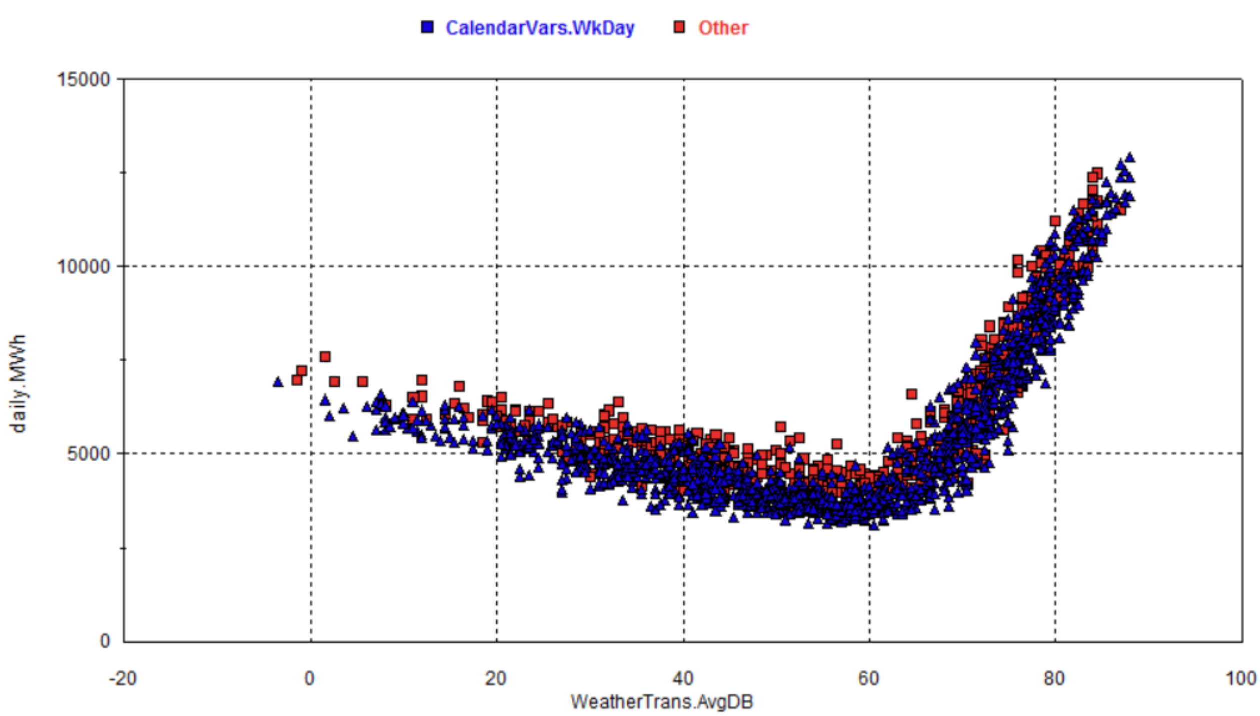


Figure 14: KS Metro Residential Daily Peak Demand vs Average Temp

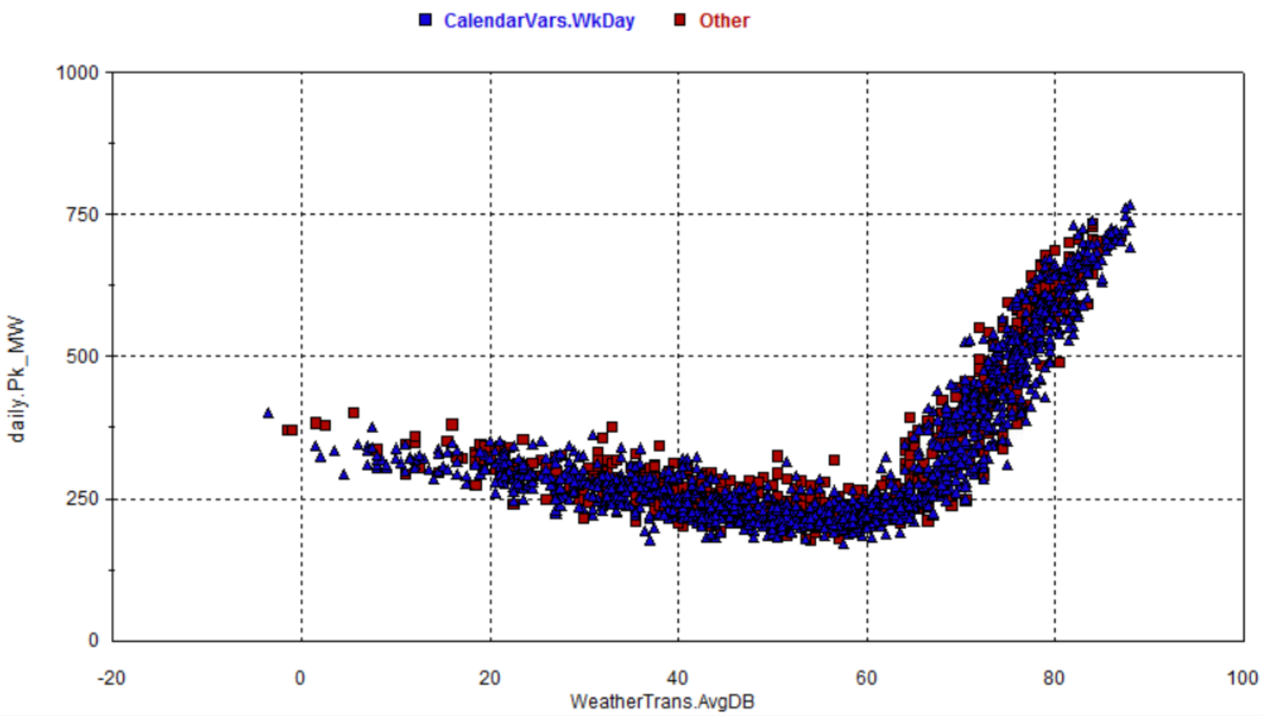


Figure 15: KS Metro Small General Service Daily Energy vs Average Temp

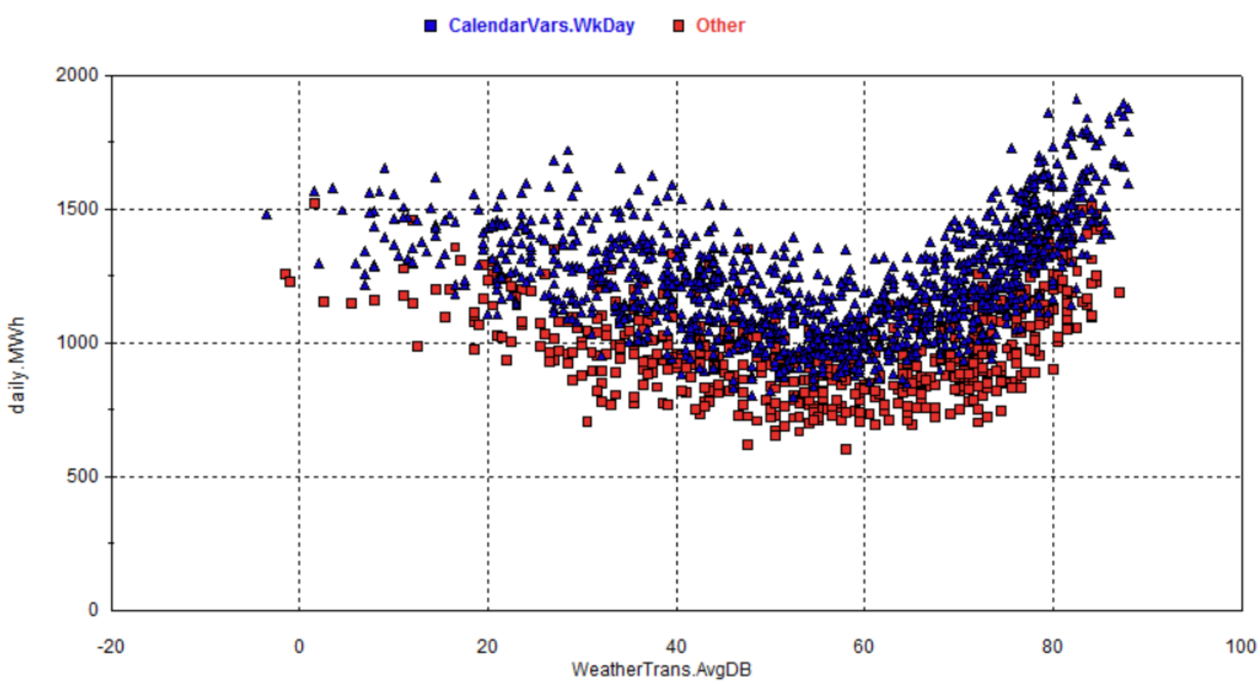


Figure 16: KS Metro Small General Service Daily Peak Demand vs Average Temp

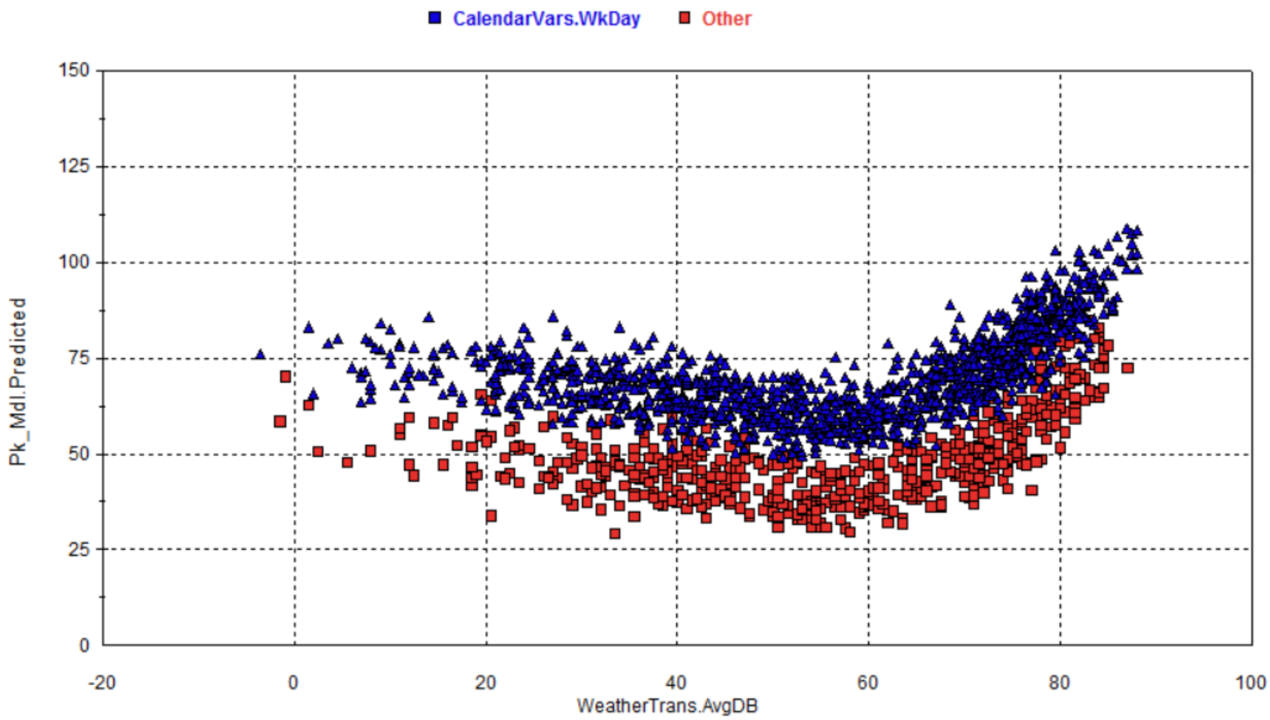


Figure 17: KS Metro Medium General Service Daily Energy vs Average Temp

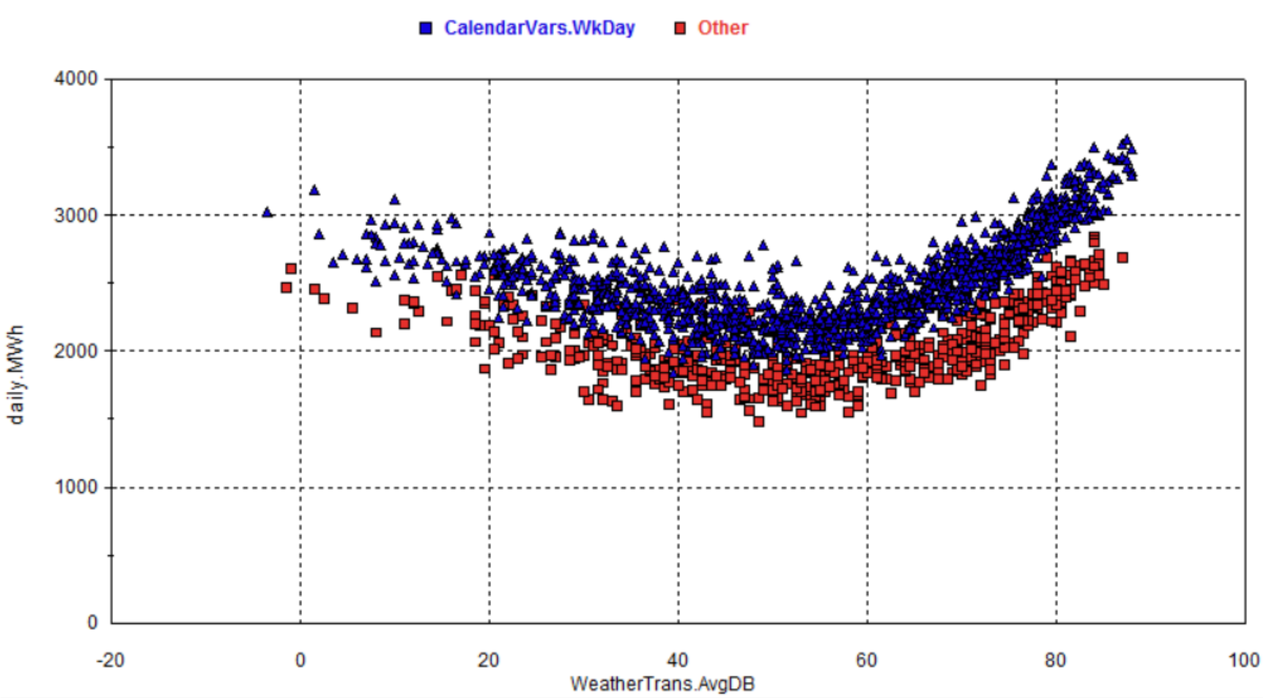


Figure 18: KS Metro Medium General Service Daily Peak Demand vs Average Temp

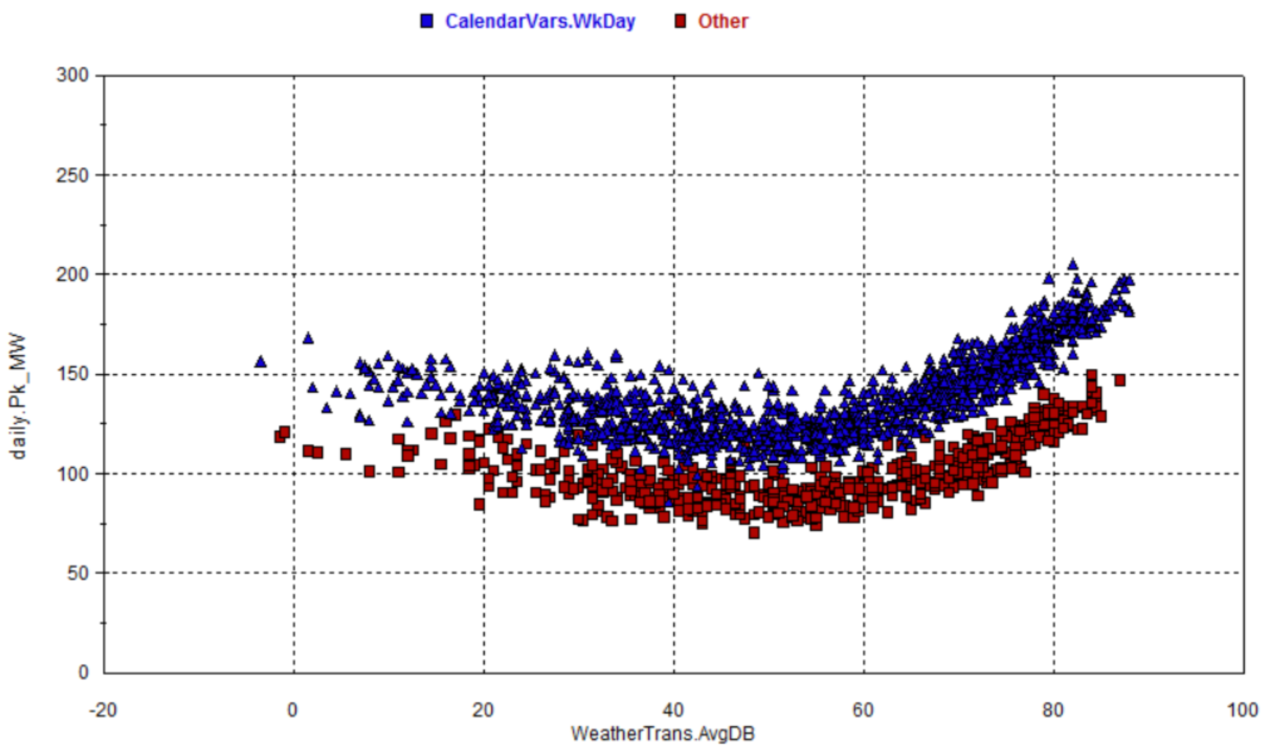


Figure 19: KS Metro Large General Service Daily Energy vs Average Temp

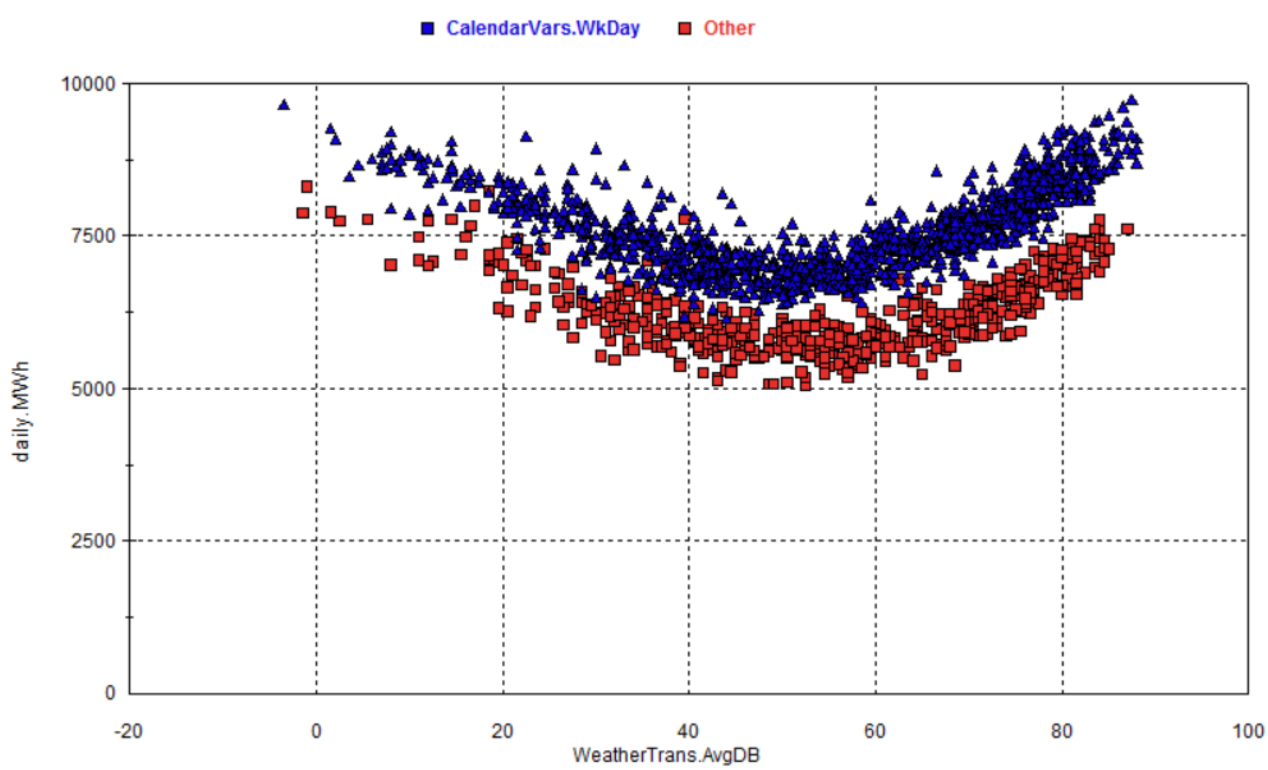


Figure 20: KS Metro Large General Service Daily Peak Demand vs Average Temp

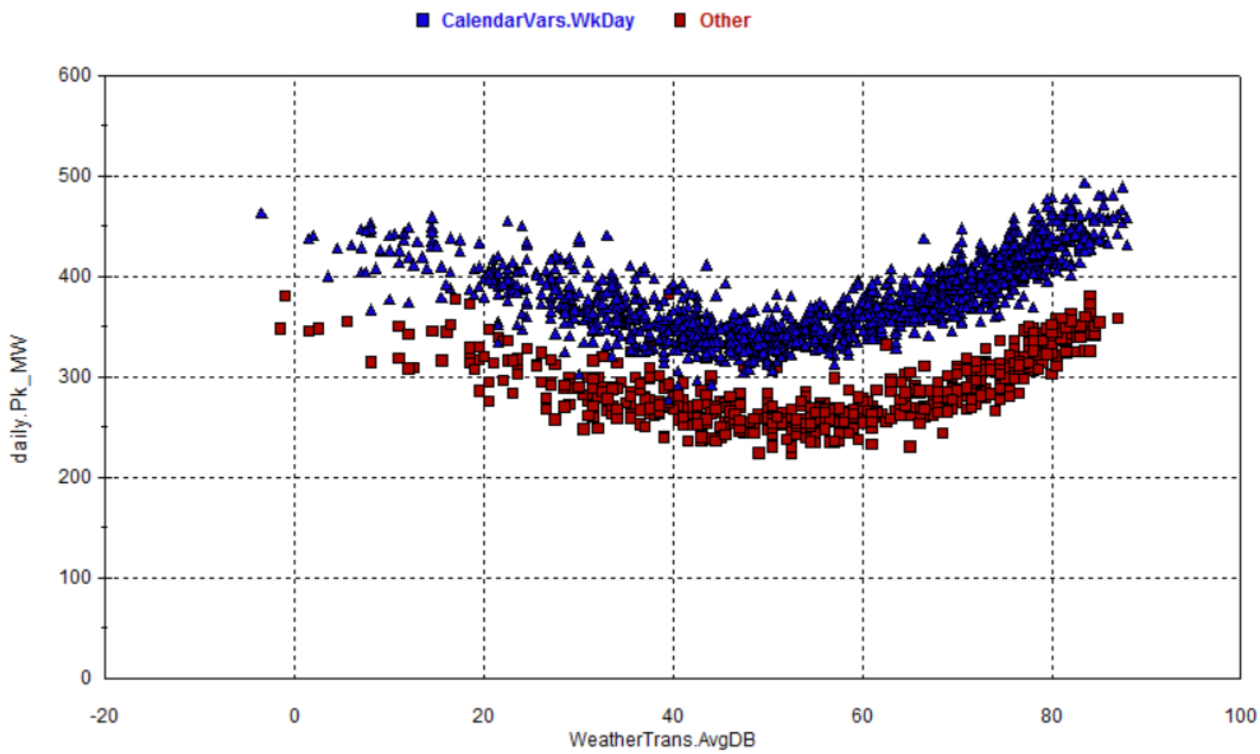


Figure 21: KS Metro Sales for Resale Daily Energy vs Average Temp

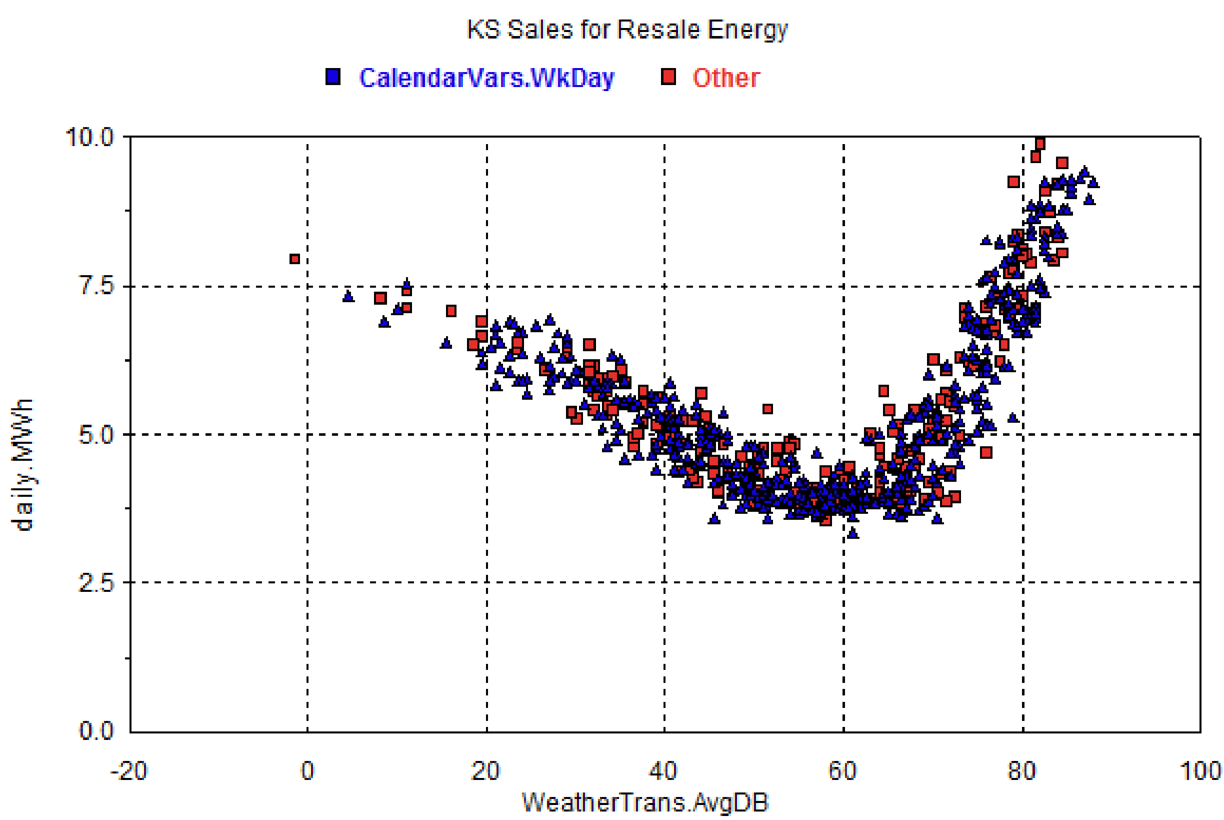
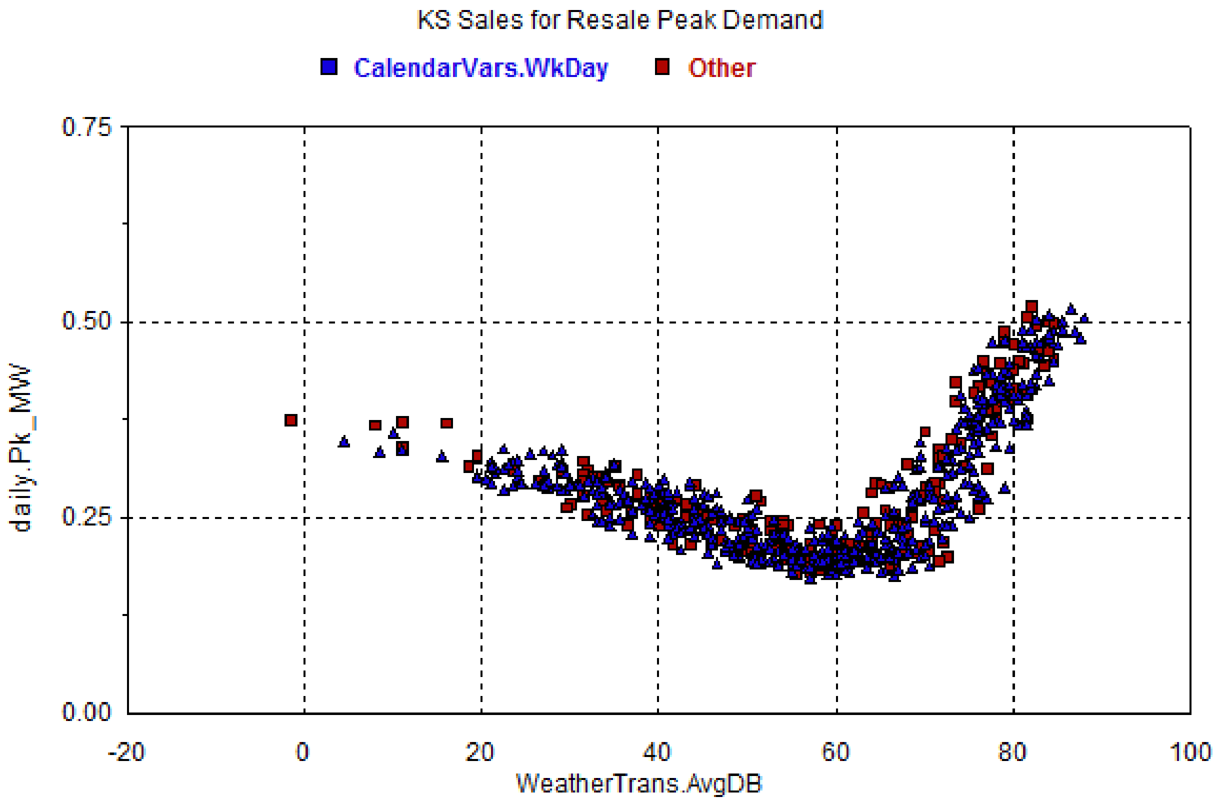


Figure 22: KS Metro Sales for Resale Daily Energy vs Average Temp



Evergy Metro-KS has zero Sales for Resale customers as of July 2017.

3. Plots illustrating trends materially affecting electricity consumption over the historical period.

Historical class plots of customers, kwh, average use and peak are provided in *Appendix 3A1* and were discussed in the section for rule (2) (D) 1.

2.5 ADJUSTMENTS TO HISTORICAL DATA DESCRIPTION AND DOCUMENTATION

(E) The utility shall describe and document any adjustments that it made to historical data prior to using it in its development or interpretation of the forecasting models; and

Evergy Metro used binary variables in regression models to explain outliers rather than adjust the data.

2.6 <u>LENGTH OF HISTORICAL DATABASE</u>

(F) Length of Historical Database. The utility shall develop and retain the historical database over the historical period.

For Evergy Metro, historical sales and customers broken out by class cost of service for residential and industrial customers were available beginning in January 2000. Commercial class cost of service data was available beginning May 2005. Going forward, Evergy Metro will maintain this data for at least the previous 10 years.

SECTION 3: ANALYSIS OF NUMBER OF UNITS

For each major class, the utility shall describe and document its analysis of the historical relationship between the number of units and the economic and/or demographic factors (explanatory variables) that affect the number of units for that major class. The analysis may incorporate or substitute the results of secondary analyses, with the proviso that the utility analyze and verify the applicability of those results to its service territory. If the utility develops primary analyses, or to the extent they are available from secondary analyses, these relationships shall be specified as statistical or mathematical models that relate the number of units to the explanatory variables.

3.1 IDENTIFICATION OF EXPLANATORY VARIABLES

(A) Choice of Explanatory Variables. The utility shall identify appropriate explanatory variables as predictors of the number of units for each major class. The critical assumptions that influence the explanatory variables shall also be identified and documented.

A forecast of the number of households in the KC metro area from Moody's Analytics was the driver for the number of residential customers of Evergy Metro. The KC metro area is the same as the Metropolitan Statistical Area (MSA) defined by the US Census Bureau and it includes some counties in both states that are not served by Evergy Metro. Also, Evergy Metro service area includes some counties that are not included in the MSA. Despite these inconsistencies in geographic areas, the number of households in the metro area is a good driver to predict the number of our residential customers because the metro area functions economically as a single entity and the metro area includes the vast majority of our customers. Many people live on one side of the state line and work on the other side. Many people shop on both sides of the state line. And many companies each year move from one side of the state line to the other. Documentation for Moody's forecast of economic activity is provided in the workpapers in the folder *\models* Evergy Metro *Base Case\Data\Economics* and Documentation\Economics.

Evergy Metro tested the use of county level forecasts from Moody’s several years ago but saw no improvement in forecasting accuracy. This might be because it is difficult to forecast economic activity for a small geographic area, or because economic activity crosses county lines in the metro area.

The residential customer models where test with both households and population used as drivers and the one with the best fit was chosen. If neither was significant or had a positive coefficient, the driver was tested without a constant term in the model, and if still insignificant, a driver was not used. Typically, households had the best fit.

The main driver for the number of small general service customers was the number of residential customers or households. These drivers were chosen because they have worked well in the past and because most small commercial customers exist to serve households and residences and these customers will increase in areas where there are new housing developments. Examples of small commercial customers that serve households are medical offices, grocery stores, drug stores, restaurants, churches, schools, hair salons, and movie theaters.

In the models for Big (Medium GS, Large GS and Large Power) commercial customers, both non-manufacturing employment and non-manufacturing gross metro product were tested as drivers, as well as population and households. The log of population produced the best fit and was chosen as the primary driver.

3.2 STATISTICAL MODEL DOCUMENTATION

(B) Documentation of statistical models shall include the elements specified in subsection (2)(C) of this rule. Documentation of mathematical models shall include a specification of the functional form of the equations if the utility develops primary analyses, or to the extent they are available if the utility incorporates secondary analyses.

The following tables show the statistics for the variables in the regression models. Additional statistics and residual plots are available in the Metrix ND model files and a word document located in Evergy Metro\Metro Model Statistics.docx. A description of the

SAE modelling framework is included in the SAE documentation workpapers in the folder Evergy Metro\Documentation\SAE.

Table 9: MO Metro Residential Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
Economics.Households	296.609	2.364	125.491	0.00%
RES_Cust.Sep19	-1282.662	557.669	-2.300	2.29%
RES_Cust.Dec19	2038.440	567.810	3.590	0.05%
RES_Cust.CalibCCB	-1348.520	689.359	-1.956	5.24%
AR(1)	0.954	0.024	40.017	0.00%
SMA(1)	0.468	0.085	5.522	0.00%

Table 10: MO Metro Small GS Commercial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
Economics.Total_Households	30.681	0.633	48.494	0.00%
SML_Cust.Oct08	-191.408	83.433	-2.294	2.32%
SML_Cust.Oct13	342.473	83.434	4.105	0.01%
SML_Cust.Oct16	-278.245	83.429	-3.335	0.11%
SML_Cust.Feb18	-371.314	83.428	-4.451	0.00%
SML_Cust.BeforeMay18	-479.169	117.921	-4.063	0.01%
AR(1)	0.976	0.015	65.367	0.00%

Table 11: MO Metro Big Commercial Customers (MGS, LGS and LP)

Variable	Coefficient	StdErr	T-Stat	P-Value
mEcon.Population_log	788.950	1.193	661.528	0.00%
mBinary.BeforeJul08	-403.211	10.990	-36.689	0.00%
mBinary.Oct13	-148.068	35.857	-4.129	0.01%
mBinary.Dec09	114.273	36.384	3.141	0.20%
mBinary.Mar10	97.671	35.832	2.726	0.71%
mBinary.TrendYR08_09	0.002	0.000	7.774	0.00%
BIG_Cust.YR06	-105.643	13.680	-7.722	0.00%
BIG_Cust.Dec08	163.254	36.371	4.489	0.00%
BIG_Cust.Dec11	85.512	35.843	2.386	1.82%
BIG_Cust.Dec16	-90.749	36.316	-2.499	1.35%
BIG_Cust.Feb18	-100.118	36.002	-2.781	0.61%
BIG_Cust.Apr18	-111.093	36.002	-3.086	0.24%
BIG_Cust.CalibCCB	79.921	13.377	5.974	0.00%
BIG_Cust.CalibSwitch1	0.001	0.000	4.543	0.00%
BIG_Cust.CalibSwitch2	0.001	0.000	3.510	0.06%
BIG_Cust.CalibSwitch3	-74.409	9.427	-7.893	0.00%
BIG_Cust.CalibCov	-182.142	25.735	-7.078	0.00%

Table 12: MO Metro Industrial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	4.709	9.713	0.485	62.84%
IND_Cust.LagDep(1)	0.994	0.009	105.802	0.00%
IND_Cust.Aug08	41.465	10.792	3.842	0.02%
IND_Cust.Aug09	-37.370	10.922	-3.421	0.08%
IND_Cust.May14	37.303	10.628	3.510	0.06%
IND_Cust.Feb18	-36.200	11.222	-3.226	0.15%
IND_Cust.Mar18	53.790	11.211	4.798	0.00%
AR(1)	-0.345	0.076	-4.564	0.00%

Table 13: KS Metro Residential Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
Economics.Households	264.199	0.951	277.769	0.00%
RES_Cust.Jul16	1248.391	350.837	3.558	0.05%
RES_Cust.May19	1121.442	338.115	3.317	0.11%
RES_Cust.Dec19	762.274	341.232	2.234	2.68%
RES_Cust.Calib	787.253	337.299	2.334	2.08%
mBinary.Jul	326.843	93.766	3.486	0.06%
mBinary.Nov	566.635	91.169	6.215	0.00%
AR(1)	0.955	0.023	41.782	0.00%

Table 14: KS Metro Small GS Commercial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
ResCustomers.RES_Cust	0.047	0.012	4.067	0.01%
Economics.Emp_NonMan	13.183	2.632	5.008	0.00%
SML_Cust.Mar07	-162.650	78.326	-2.077	3.96%
SML_Cust.Jul10	333.070	77.628	4.291	0.00%
SML_Cust.Oct11	-261.186	88.907	-2.938	0.38%
SML_Cust.Nov11	-213.328	88.960	-2.398	1.77%
mBinary.Aug11	422.049	77.550	5.442	0.00%
SML_Cust.Feb13	-364.842	77.164	-4.728	0.00%
SML_Cust.Jul16	-1270.530	91.400	-13.901	0.00%
SML_Cust.Aug16	-480.328	89.156	-5.387	0.00%
SML_Cust.May18	228.809	78.422	2.918	0.41%
SML_Cust.BeforeMar14	-445.917	92.043	-4.845	0.00%
mBinary.Apr	-60.589	21.015	-2.883	0.45%
AR(1)	0.883	0.039	22.641	0.00%

Table 15: KS Metro Big GS Commercial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
mEcon.Population_log	685.761	4.700	145.917	0.00%
BIG_Cust.Jul08	64.451	35.709	1.805	7.31%
BIG_Cust.Sep11	195.147	43.169	4.521	0.00%
BIG_Cust.Oct11	409.325	49.544	8.262	0.00%
BIG_Cust.Nov11	88.511	43.148	2.051	4.20%
BIG_Cust.Mar13	113.471	35.648	3.183	0.18%
BIG_Cust.Apr17	195.101	40.871	4.774	0.00%
BIG_Cust.May17	12.090	40.871	0.296	76.78%
BIG_Cust.Calib	-88.316	36.635	-2.411	1.71%
BIG_Cust.Aug17	-121.871	35.661	-3.417	0.08%
BIG_Cust.Feb12	112.060	35.623	3.146	0.20%
AR(1)	0.817	0.046	17.861	0.00%

Table 16: KS Metro Industrial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	3.497	2.361	1.481	14.05%
IND_Cust.LagDep(1)	0.995	0.002	406.532	0.00%
IND_Cust.Sep08	17.718	5.783	3.064	0.25%
MA(1)	-0.900	0.034	-26.307	0.00%

The variables ending with month and year, shown in the tables above, are defined as 1 for that month and 0 for all other months.

No economic drivers were significant in the model for industrial customers in Kansas Metro.

SECTION 4: USE PER UNIT ANALYSIS

For each major class, the utility shall describe and document its analysis of historical use per unit by end use.

4.1 END-USE LOAD DETAIL

(A) End-Use Load Detail. For each major class, use per unit shall be disaggregated, where information permits, by end-uses that contribute significantly to energy use or peak demand.

4.1.1 END-USE LOAD INFORMATION

1. The utility shall consider developing information on at least the following end-use loads:

4.1.1.1 Residential Sector

A. For the residential sector: lighting, space cooling, space heating, ventilation, water heating, refrigerators, freezers, cooking, clothes washers, clothes dryers, television, personal computers, furnace fans, plug loads, and other uses;

The list of residential end-uses that Evergy Metro maintains the number of units and energy use per unit include electric furnaces, heat pumps with electric resistance backup, heat pumps with natural gas backup, ground source heat pumps, central air conditioning without a heat pump, window or wall AC units, electric water heaters, electric ovens, cook tops and ranges, full-sized refrigerators, small refrigerators and wine coolers, freezers, dishwashers, clothes washers, electric dryers, TVs, air cleaners, computers, video game systems, hot tubs, swimming pools, electric vehicles and miscellaneous uses.

4.1.1.2 Commercial Sector

B. For the commercial sector: space heat, space cooling, ventilation, water heat, refrigeration, lighting, office equipment, cooking equipment, and other uses; and

Evergy Metro maintains information on saturations per square foot of floor space and energy use per square foot (EUI) for end-uses including heating, cooling, ventilation, electric water heating, electric cooking, refrigeration, outdoor lighting, indoor lighting, and office equipment and miscellaneous uses. In this filing, secondary data from the U.S. DOE for the West North Central region was adopted for both Evergy Metro Kansas and Missouri. The region includes the states of North Dakota, South Dakota, Minnesota, Iowa, Nebraska, Kansas and Missouri. The results are combined across building types using building type weights. The building types include assembly (theaters, libraries, churches etc.), education, food sales, food service, health care, lodging, small office, large office, mercantile/service, warehouse and other. This data is maintained in *ComIndices_MO.xls* and *ComIndices_KS.xls*. The building types are defined in NEMS to NAICS Mapping*.xls*. These spreadsheets were provided to Evergy Metro by Itron Inc. through the Energy Forecasting Group (EFG). The spreadsheets are documented in *2020_CommercialSAE.pdf*. These files are provided in the workpapers.

4.1.1.3 Industrial Sector

C. For the industrial sector: machine drives, space heat, space cooling, ventilation, lighting, process heating, and other uses.

Evergy Metro has a relatively small industrial sector, accounting for approximately 12% of retail sales. Evergy Metro lacks the concentration of heavy industry that some utilities have. As such, we have modeled our industrial sector with a statistically adjusted employment-based intensity model. Major end-uses are cooling and other.

4.1.2 MODIFICATION OF END-USE LOADS

2. The utility may modify the end-use loads specified in paragraph (4)(A)1.

4.1.2.1 Removal or Consolidation of End-Use Loads

A. The utility may remove or consolidate the specified end-use loads if it determines that a specified end-use load is not contributing, and is not likely to contribute in the future, significantly to energy use or peak demand in a major class.

Evergy Metro dropped attic fans from its residential survey since these do not contribute significantly to energy use or peak demand.

4.1.2.2 Additions to End-Use Loads

B. The utility shall add to the specified end-use loads if it determines that an end-use load currently not specified is likely to contribute significantly to energy use or peak demand in a major class.

In 2011 Evergy Metro added electric vehicles (including PHEVs) to our database. In the 2020 base year forecast we incorporated EV adoption forecasts produced in an ongoing study of Evergy Metro service territory EV usage conducted in partnership with the Electric Power Research Institute.

Starting with the 2013 base year forecast, we began tracking solar installations and merged that tracking with the EIA forecast estimate in 2015 to start generating a solar end-use intensity forecast for use in our residential and commercial forecasts.

4.1.2.3 Modification of End-Use Documentation

C. The utility shall provide documentation of its decision to modify the specified end-use loads for which information is developed, as well as an assessment of how the modifications can be made to best preserve the continuity and integrity of the end-use load database.

Evergy Metro dropped the end-uses listed in the previous section A because they do not contribute significantly to energy use. The following end-uses were added to the residential survey: well pumps, video game systems, medical equipment, smart speaker, streaming devices, home theater system because these use substantial amounts of energy or we believed that these had a significant saturation in our service areas.

The DOE lighting end use estimates for both Residential and Commercial were adjusted for slope as well as total size to better align with historical Evergy Metro adoption of efficient lighting technologies and to align with the estimated remaining efficiency potential. The appliance saturation surveys were used to calibrate the DOE lighting projections. Documentation of this calibration is included in the class end use worksheets located in the folder Evergy Metro\Models\KCPL Base Case\Data\Indices.

A study and projection of electric vehicle utilization and load impact was incorporated in the current forecast. The study suggests that electric vehicle utilization is likely to significantly impact our energy load in the future. The available resources underlying the study results are included in our work-papers.

4.1.3 SCHEDULE FOR ACQUIRING END-USE LOAD INFORMATION

3. For each major class and each end-use load, including those listed in paragraph (4)(A)1., if information is not available, the utility shall provide a schedule for acquiring this end-use load information or demonstrate that either the expected costs of acquisition were found to outweigh the expected benefits over the planning horizon or that gathering the end-use load information has proven to be infeasible.

Evergy Metro completed a DSM potential study in 2020. The study collected detailed end-use saturation and efficiency data from our customers in the residential, commercial and industrial sectors. Evergy Metro provided copies of the completed study to stakeholders' group.

4.1.4 WEATHER EFFECTS ON LOAD

4. The utility shall determine the effect that weather has on the total load of each major class by disaggregating the load into its cooling, heating, and non-weather-sensitive components. If the cooling or heating components are a significant portion of the total load of the major class, then the cooling or heating components of that load shall be designated as enduses for that major class.

Evergy Metro used statistical regression analysis applied to the load research data to develop HELM like hourly load profiles for each month, for three different day types and for base, heating and cooling loads. The three-day types are weekdays, weekends and peak days. Daily temperature was used in the regression models to identify the heating and cooling portions of the loads. The profiles were developed for each CCOS. The regressions were performed in MetrixND projects MetroMO_ClassProfile.NDM, MetroKS_ClassProfile.NDM using 2017-2019 load research data.

These load profiles are used in this IRP filing to allocate base, heating and cooling energy to each hour on an annual and monthly basis. These profiles are stored in MetroMO_ClassEndUse.ltm, MetroMO_ClassEndUseWN.ltm, MetroKS_ClassEndUse.ltm and MetroKS_ClassEndUseWN.ltm.

4.2 END-USE DEVELOPMENT

(B) The database and historical analysis required for each end use shall be developed from a utility-specific survey or other primary data. The database and analysis may incorporate or substitute the results of secondary data, with the proviso that the utility analyze and verify the applicability of those results to its service territory. The database and historical analysis required for each end use shall include at least the following:

4.2.1 MEASURES OF THE STOCK OF ENERGY-USING CAPITAL GOODS

1. Measures of the stock of energy-using capital goods. For each major class and end-use load identified in subsection (4)(A), the utility shall implement a procedure to develop and maintain adequate data on the energy-related characteristics of the building, appliance and equipment stock including saturation levels, efficiency levels, and sizes, where applicable. The utility shall update the data before each triennial compliance filing; and

Evergy Metro has conducted a residential appliance saturation survey every 3 years for many decades. The surveys have been conducted by mail historically and recently by a mix of mail and internet methods. The last survey was conducted in the third quarter of 2019 in conjunction with the 2020 potential study and included a combination of both paper and web surveys. Evergy Metro received 851 and 1,083 survey responses from residential customers in Missouri and Kansas respectively. The survey responses were matched with each customers’ billing records for the previous 12 months and with heating and cooling degree days computed for the billing period and the combined data was used in a conditional demand study to estimate the energy used by each type of appliance.

Evergy Metro conducted a DSM potential study that was completed in 2020. This study collected detailed end-use saturation and efficiency data from our customers in the residential, commercial and industrial sectors. Evergy Metro provided copies of the final report to the Stakeholders' group.

A commercial and industrial (C&I) saturation survey was conduct in 2019 in addition to the residential appliance saturation survey. The C&I survey was conducted as a single jurisdictional survey due to the sample size. There were 845 completed surveys which were allocated across strata and by SIC segment (Office, Retail, Restaurant, Grocery, College, Schools, Health, Lodging, Warehouse, Misc., Energy Intensive Mfg., Non-Intensive Mfg., Other Industrial, and Unknow). The C&I surveys were completed via Computer-Assisted Telephone Interviewing (CATI).

The C&I survey captured information about a wide range of features of customer business facilities, including the following:

- Business / building characteristics
- Heating and cooling systems (fuel type, primary /secondary, controls, and % of space)
- Water heating (type, fuel, and size)
- Lighting (number by type, controls, and operating hours)
- Electronic equipment
- Other end uses (electronics, kitchens, warehouse space, motors, etc.)
- Energy efficiency-related improvements

4.2.2 END-USE ENERGY AND DEMAND ESTIMATES

2. Estimates of end-use energy and demand. For the end-use loads identified in subsection (4)(A), the utility shall estimate monthly energies and demands at the time of monthly system peaks and shall calibrate these energies and demands to equal the weather-normalized monthly energies and demands at the time of monthly peaks for each major class for the most recently available data.

Monthly energies for the end-uses that are included in our SAE models are calibrated in the SAE models to monthly billed sales for each CCOS. The coefficients for the base, heating and cooling loads calibrate those loads and the coefficient for the base load raises or lowers all the components of the base load when the base load is calibrated to monthly billed sales.

Monthly demand for the major end-uses that are included in our SAE models are calibrated to the time of the monthly system peaks. This is done in the models by taking the hourly system demands and matching them to the hourly class end-use demands. This computes the coincident peak by class and end-use. To calibrate class end-use demands to the weather normalized system peak, the system peak and weather normalized peaks are used to develop a calibration factor that is applied to each class and end-use. This process is done for both Missouri and Kansas. This process is completed in an Excel worksheet which is provided in the workpapers.

SECTION 5: SELECTING LOAD FORECASTING MODELS

The utility shall select load forecast models and develop the historical database needed to support the selected models. The selected load forecast models will include a method of end-use load analysis for at least the residential and small commercial classes, unless the utility demonstrates that end-use load methods are not practicable and provides documentation that other methods are at a minimum comparable to end-use methods. The utility may choose multiple models and methods if it deems doing so is necessary to achieve all of the purposes of load forecasting and if the methods and models are consistent with, and calibrated to, one another. The utility shall describe and document its intended purposes for load forecast models, why the selected load forecast models best fulfill those purposes, and how the load forecast models are consistent with one another and with the end-use usage data used in the demand-side analysis as described in 4 CSR 240-22.050. As a minimum, the load forecast models shall be selected to achieve the following purposes:

5.1 CONSUMPTION DRIVERS AND USAGE PATTERNS

(A) Assessment of consumption drivers and customer usage patterns—to better understand customer preferences and their impacts on future energy and demand requirements, including weather sensitivity of load;

Evergy Metro uses the Statistically Adjusted End-use (SAE) method to forecast energy sales and demand for all classes except lighting and sales for resale. The SAE method creates a forecast of sales at the end-use level and then for each class aggregates the forecasts into base, heating and cooling energy and then calibrates these loads to monthly billed sales using statistical regressions.

Our end-use level forecasts are developed using both primary data collected by Evergy Metro and secondary data and projections produced by the U.S. Department of Energy (DOE) for the West North Central region of the U.S. DOE projections used in our models include projections of saturations for household appliances and equipment used in commercial buildings and projections of efficiencies for appliances, buildings and equipment. DOE has a large professional staff that is responsible for constructing and maintaining energy demand models and for managing contractors. The contractors survey households, businesses and buildings on a regular schedule. Contractors are also used to conduct special studies. DOE's projections are designed to account for changes in consumer preferences, technology and building design practices. Their projections also account for the impacts of appliance and equipment standards. DOE updates its projections at least once a year and we use the most recently available projections whenever we update our models.

Evergy Metro calibrates DOE appliance saturation projections to the saturation numbers that we obtain from our residential surveys. We also calibrate DOE's projections of unit energy consumption (UEC) for appliances to the results of our conditional demand study.

Itron hosts an annual meeting for the Energy Forecasting Group (EFG), which supports utilities that use the SAE method to forecast their sales. DOE staff attends the meeting of the EFG (which we attend) to explain changes in the assumptions, data and methods that have occurred during the previous year. Their slide decks provided during these meetings for the past several years are included in our workpapers. On their website, DOE provides detailed documentation and computer code for their models and assumptions.

5.2 LONG-TERM LOAD FORECASTS

(B) Long-term load forecasts—to serve as a basis for planning capacity and energy service needs. This can be served by any forecasting method or methods that produce reasonable projections (based on comparing model projections of loads to actual loads) of future demand and energy loads;

Evergy Metro believes that the SAE methodology is the best available for producing our load forecasts. DOE forecasts the impacts of all appliance and equipment standards, most of which will substantially increase efficiency.[i] DOE also models trends in appliance ownership and utilization.

The Annual Energy Outlook for 2020 (AEO2020) differed from the AEO2017 filed in the previous IRP forecast for both the residential and commercial outlooks. The residential outlook had changes for the following:

- Updated housing stock formation and decay
- Residential photovoltaic (PV)
- Incorporation of the 2015 Residential Energy Consumption Survey (RECS) base year
- A smoother, less erratic projection of Miscellaneous electric loads (MEL)

Total Residential intensity follows a growth trajectory very similar to the 2017 Annual Energy Outlook over the 20 year period 2020-2040, with both at -0.2%. A slightly moderated decline in Cooling intensity is offset by slower growth in Base (non-HVAC) consumption.

For the commercial outlook, changes were made for the following:

- End-use energy intensity projections
- End-use efficiency projections
- Revised historical saturations and efficiencies

The majority of the end-uses decreased in intensity in the 2020 outlook compared to the 2017 outlook, resulting in a decrease in total intensity over the 2020-2040 planning period from 0.0% in the 2017 AEO to -0.5% in the 2020 AEO.

5.3 POLICY ANALYSIS

(C) Policy analysis—to assess the impact of legal mandates, economic policies, and rate designs on future energy and demand requirements. The utility may use any load forecasting method or methods that it demonstrates can adequately analyze the impacts of legal mandates, economic policies, and rate designs.

Evergy Metro believes that the SAE approach is the best available method to incorporate the impacts of appliance and equipment efficiency standards because the DOE is the best qualified institution to estimate these impacts. DOE will also incorporate any federal legal impacts into its forecasts. For example, DOE has incorporated CAFÉ regulations into its forecasts of electric vehicle unit sales, which in turn impacts kWh sales for recharging EVs.

Table 17: Residential Product Categories Covered by DOE Standards[ii]

Product Covered	Initial Legislation	Last Standard Published	Compliance Date	Issued By	Proposed Standards Due	New Final Standard Due	Potential Compliance Date	States With Standard
Battery Chargers	EPACT 2005	2016	2018	DOE	2022	2024	2026	CA, OR
Boilers	NAECA 1987	2016	2021	DOE	2022	2024	2029	
Ceiling Fans	EPACT 2005	2017	2020	DOE	2023	2025	2028	
Central Air Conditioners and Heat Pumps	NAECA 1987	2017	2023	DOE	2023	2025	2030	
Clothes Dryers	NAECA 1987	2011	2015	DOE	2017	2019	2022	
Clothes Washers	NAECA 1987	2012	2018	DOE	2018	2020	2024	
Compact Audio Equipment								CA, CT, OR
Computers and Computer Systems				N/A				CA, CO, HI, VT, WA
Cooking Products	NAECA 1987	2009	2012	DOE		2017	2020	
Dehumidifiers	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Direct Heating Equipment *	NAECA 1987	2010	2013	DOE	2019	2021	2024	
Dishwashers *	NAECA 1987	2012	2013	DOE	2019	2021	2024	
DVD Players and Recorders								CA, CT, OR
Electric Vehicle Supply Equipment								
External Power Supplies	EPACT 2005	2014	2016	DOE		2021		CA
Faucets	EPACT 1992	1992	1994	Congress				CA, CO, HI, NY, VT, WA
Furnace Fans	EPACT 2005	2014	2019	DOE	2020	2022	2025	
Furnaces	NAECA 1987	2007	2015	DOE		2016		
Game Consoles				N/A				
Hearth Products				N/A				
Lawn Spray Sprinklers								CA, CO, HI, VT, WA
Microwave Ovens	NAECA 1987	2013	2016	DOE	2019	2021	2024	
Miscellaneous Refrigeration Products		2016	2019	DOE	2022	2024	2027	
Pool Heaters	NAECA 1987	2010	2013	DOE	2016	2018	2021	
Pool Pumps		2017	2021	DOE	2023	2025	2028	
Portable Air Conditioners	NAECA 1987	2020	2025	DOE	2026	2028	2031	CA, CO, VT, WA
Portable Electric Spas								AZ, CA, CO, CT, OR, VT, WA
Refrigerators and Freezers	NAECA 1987	2011	2014	DOE	2017	2019	2022	
Residential Ventilating Fans								CO, VT, WA
Room Air Conditioners	NAECA 1987	2011	2014	DOE	2017	2019	2022	
Set-top Boxes				N/A				
Showerheads	EPACT 1992	1992	1994	Congress				CA, CO, HI, NY, VT, WA
Televisions	NAECA 1987			N/A				CA, CT, OR
Toilets	EPACT 1992	1992	1994	Congress				CA, CO, GA, NY, TX, WA
Water Heaters	NAECA 1987	2010	2015	DOE	2016	2018	2023	

Table 18: Commercial/Industrial Product Categories Covered by DOE Standards[iii]

Product Covered	Initial Legislation	Last Standard Published	Compliance Date	Issued By	Proposed Standards Due	New Final Standard Due	Potential Compliance Date	States With Standard
Automatic Commercial Ice Makers	EPACT 2005	2015	2018	DOE	2021	2023	2026	
Beverage Vending Machines	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Commercial Boilers	EPACT 1992	2020	2023	DOE	2026	2028	2031	
Commercial CAC and HP (65,000 Btu/hr to 760,000 Btu/hr)	EPACT 1992	2016	2018	DOE	2022	2024	2029	
Commercial CAC and HP (<65,000 Btu/hr)	EPACT 1992	2015	2017	DOE	2021	2023	2026	
Commercial CAC and HP (Water- and Evaporatively-Cooled)	EPACT 1992	2012	2013	DOE	2018	2020	2023	
Commercial Clothes Washers	EPACT 2005	2014	2018	DOE	2020	2022	2025	
Commercial Dishwashers								CO, VT, WA
Commercial Fryers								CO, VT, WA
Commercial Ovens								
Commercial Refrigeration Equipment	EPACT 2005	2014	2017	DOE		2020	2023	
Commercial Steam Cookers								CO, VT, WA
Commercial Warm Air Furnaces	EPACT 1992	2016	2023	DOE	2022	2024	2029	
Commercial Water Heaters	EPACT 1992	2001	2003	DOE		2018	2021	
Compressors		2020	2025	DOE	2026	2028	2031	CA, CO, VT, WA
Computer Room Air Conditioners	EPACT 1992	2012	2013	DOE		2018	2021	
Distribution Transformers: Liquid-Immersed	EPACT 1992	2013	2016	DOE	2019	2021	2024	
Distribution Transformers: Low-Voltage Dry-Type	EPACT 2005	2013	2016	DOE	2019	2021	2024	
Distribution Transformers: Medium-Voltage Dry-Type	EPACT 1992	2013	2016	DOE	2019	2021	2024	
Electric Motors	EPACT 1992	2014	2016	DOE	2020	2022	2025	
Fans and Blowers	EPACT 1992			N/A				
Hot Food Holding Cabinets								CA, CO, CT, DC, MD, NH, OR, RI, VT, WA
Packaged Terminal AC and HP	EPACT 1992	2015	2017	DOE	2021	2023	2026	
Pre-Rinse Spray Valves	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Pumps, Commercial and Industrial	EPACT 1992	2016	2020	DOE	2022	2024	2027	
Single Package Vertical Air Conditioners and Heat Pumps	EPACT 1992	2015	2019	DOE	2021	2023	2026	
Small Electric Motors	EPACT 1992	2010	2015	DOE	2016	2018	2021	
Uninterruptible Power Supplies	EPACT 2005	2020	2020	DOE	2026	2028	2030	CO, VT, WA
Unit Heaters	EPACT 2005	2005	2008	Congress				
Urinals	EPACT 1992	1992	1994	Congress				CA, CO, NY, TX, VT, WA
Walk-In Coolers and Freezers	EISA 2007	2014	2017	DOE		2020	2023	
Water Dispensers								CA, CO, CT, DC, MD, NH, OR, RI, VT, WA
Water-Source Heat Pumps	EPACT 1992	2015	2015	DOE	2021	2023	2026	

Table 19: Lighting Product Categories Covered by DOE Standards[iv]

Product Covered	Initial Legislation	Last Standard Published	Compliance Date	Issued By	Proposed Standards Due	New Final Standard Due	Potential Compliance Date	States With Standard
Candelabra & Intermediate Base Incandescent Lamps		2007	2012	Congress				
Ceiling Fan Light Kits	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Compact Fluorescent Lamps	EPACT 2005	2005	2006	Congress				
Deep-Dimming Fluorescent Ballasts								CA
Fluorescent Lamp Ballasts	NAECA 1988 1988	2011	2014	DOE	2017	2019	2022	
General Service Fluorescent Lamps	EPACT 1992	2015	2018	DOE	2021	2023	2026	
General Service Lamps	EISA 2007	2007	2012	Congress		2022	2025	CA, CO, NV, VT, WA
HID Lamps	EPACT 1992	2015		DOE	2018	2020	2023	
High Light Output Double-Ended Quartz Halogen Lamps								OR
HIgh-CRI Linear Fluorescent Lamps								CO, HI, VT, WA
Illuminated Exit Signs	EPACT 2005	2005	2006	Congress				
Incandescent Reflector Lamps	EPACT 1992	2009	2012	DOE		2014	2017	
Incandescent Reflector Lamps (includes certain BR and Other Exempted IRLs)	EPACT 1992			N/A				
Luminaires	EPACT 1992			N/A				
Mercury Vapor Lamp Ballasts	EPACT 2005	2005	2008	Congress				
Metal Halide Lamp Fixtures	EISA 2007	2014	2017	DOE		2019	2022	CA
Small-Diameter Directional Lamps								CA
Torchiere Lighting Fixtures	EPACT 2005	2005	2006	Congress				
Traffic Signals	EPACT 2005	2005	2006	Congress				

SECTION 6: LOAD FORECASTING MODEL SPECIFICATIONS

6.1 DESCRIPTION AND DOCUMENTATION

(A) For each load forecasting model selected by the utility pursuant to section 4 CSR 240-22.030(5), the utility shall describe and document its—

6.1.1 DETERMINATION OF INDEPENDENT VARIABLES

1. Determination of appropriate independent variables as predictors of energy and peak demand for each major class. The critical assumptions that influence the independent variables shall also be identified.

In the models of residential use per customer, the independent variables were appliance saturations, appliance UECs, the real price of electricity, real per capita income and persons per household. The appliance saturations and UEC forecasts were adopted from DOE's forecast for the west north central region. The critical assumptions influencing the forecasts of saturations and UECs are discussed in workpapers located in documentation/SAE/assumptions and describes the model assumptions, computational methodology, parameter estimation techniques. These forecasts incorporate appliance ownership trends, trends in efficiency, updated building standards and technological change.

The forecasts of real per capita income and persons per household were produced by Moody's analytics for the KC metro area. Moody's documents its methodology in *micromodel_methodology.pdf*, *State Model Methodology.pdf* and Metro_Model_Methodology*.pdf*, which are supplied in the workpapers. These independent variables were used to construct an end-use forecast of residential use per customer for three major enduses: heating, cooling and other, and these were then calibrated to monthly billed sales per customer in a linear regression. This is described in *Appendix B: Residential SAE Modeling Framework* in the file *Res2020SAEUpdate.pdf*.

In the models of commercial sales and use per customer, the independent variables were equipment saturations and EUIs, the real price of electricity and economic variables. Economic variables were non-manufacturing employment or non-manufacturing GMP. The forecasts from DOE incorporate trends in equipment saturations, equipment efficiencies, equipment standards, building standards and technological change. These independent variables were used to construct an end-use forecast of commercial use for three major enduses: heating, cooling and other, and these were then calibrated to monthly billed sales or sales per customer in a linear regression. This is described in *Appendix A: Commercial Statistically Adjusted End-Use Model* in the file *2020CommercialSAE.pdf*.

In the models of industrial sales, the independent variables were EUIs on an industry and employment basis, the real price of electricity and economic variables. Economic variables were manufacturing employment or manufacturing GMP.

The forecasts from DOE incorporate trends in equipment saturations, equipment efficiencies, equipment standards, building standards and technological change. These independent variables were used to construct an intensity forecast of aggregated across industrial segments and these were then calibrated to monthly billed sales or sales per customer in a linear regression. This is described in *Appendix A: Commercial Statistically Adjusted End-Use Model* in the file *2020CommercialSAE.pdf*.

A. The utility shall assess the applicability of the historical explanatory variables pursuant to subsection (3)(A) to its selected forecast model.

The explanatory variables used by Evergy Metro in its forecasting models incorporate the most important drivers of energy use. These drivers are energy standards, building standards, trends in saturations and equipment efficiency, economic growth at the sector level and existing company energy efficiency and DSM programs.

B. To the extent that the independent variables selected by the utility differ from the historical explanatory variables, the utility shall describe and document those differences;

Evergy Metro has used the SAE approach since 2004 to forecast its loads. The economic drivers for the residential sector have been the number of households in the KC metro area during this time period. This is the second triennial filling that Evergy Metro has modeled small commercial (SGS), big commercial (MGS, LGS, and LP) and industrial sales (SGS, MGS, LGS, and LP) using the statistically adjusted end-use method.

For this filing, we are using updated projections from DOE for 2020 and a June 2020 vintage economic forecast of the KC metro area from Moody's Analytics.

2. Development of any mathematical or statistical equations comprising the load forecast models, including a specification of the functional form of the equations; and

Table 20: MO Metro Residential kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_RES	0.680	0.009	78.604	0.00%	kWh/cust
mStrucVars.XCool65_RES	0.740	0.007	100.653	0.00%	kwh/cust
mStrucVars.XOther_RES	1.184	0.011	111.662	0.00%	kWh/cust
RES_AvgUse.Yr09	-18.983	5.933	-3.199	0.18%	
RES_AvgUse.Nov09	87.617	19.782	4.429	0.00%	
RES_AvgUse.Aug10	-61.477	19.199	-3.202	0.18%	
RES_AvgUse.Feb11	-56.486	18.646	-3.029	0.30%	
RES_AvgUse.Apr12	-47.384	18.412	-2.574	1.13%	
RES_AvgUse.Jul12	-57.975	19.414	-2.986	0.34%	
RES_AvgUse.Feb15	-50.038	18.410	-2.718	0.75%	
RES_AvgUse.CalibCCB	-24.324	6.684	-3.639	0.04%	
RES_AvgUse.Calib	-16.508	3.698	-4.464	0.00%	
mBinary.Mar	16.262	5.697	2.854	0.51%	
mBinary.Jun	-52.380	5.920	-8.847	0.00%	
mBinary.Aug	28.629	7.186	3.984	0.01%	
mBinary.Nov	-30.986	6.395	-4.845	0.00%	
mBinary.CalibCov	21.788	12.636	1.724	8.72%	

Table 21: MO Metro Small GS Commercial kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_SML	0.985	0.050	19.867	0.00%	kWh/cust
mStrucVars.XCool60_SML	0.687	0.025	27.101	0.00%	kWh/cust
mStrucVars.XOther_SML	0.334	0.103	3.249	0.15%	kWh/cust
SML_AvgUse.Dec08	-134.222	60.480	-2.219	2.81%	
SML_AvgUse.Dec15	143.082	58.037	2.465	1.49%	
SML_AvgUse.Nov17	184.335	57.255	3.220	0.16%	
SML_AvgUse.CalibSwitch1	-0.058	0.024	-2.382	1.86%	
SML_AvgUse.CalibSwitch2	-0.111	0.035	-3.213	0.16%	
SML_AvgUse.CalibSwitch3	0.184	0.019	9.860	0.00%	
mBinary.CalibCov	-223.908	52.402	-4.273	0.00%	
MA(1)	0.305	0.086	3.546	0.05%	

Table 22: MO Metro Big GS Commercial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_BIG	436.409	18.962	23.014	0.00%	kWh
mStrucVars.XCool60_BIG	449.573	9.019	49.847	0.00%	Kwh
mStrucVars.XOther_BIG	375.508	20.887	17.978	0.00%	kWh
BIG_Sales.Sep11	16317695.857	5937971.440	2.748	0.68%	
BIG_Sales.Jan15	17676222.106	6058137.158	2.918	0.42%	
BIG_Sales.Feb19	16484903.172	6095097.977	2.705	0.77%	
BIG_Sales.Jul19	-18593891.752	6066051.697	-3.065	0.26%	
mBinary.Oct	11459322.820	1943537.189	5.896	0.00%	
mBinary.Nov	-6678546.793	1972804.349	-3.385	0.09%	
BIG_Sales.CalibBIG	6167257.057	1426659.742	4.323	0.00%	
BIG_Sales.CalibBigTrend	4484.491	101.898	44.010	0.00%	
BIG_Sales.BeforeMay18	7758011.895	1567545.483	4.949	0.00%	
mBinary.CalibCov	-57902732.150	4223636.618	-13.709	0.00%	

Table 23: MO Metro Industrial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XCool60_IND	14036.263	1079.351	13.004	0.00%	KWH
mStrucVars.XOther_IND	12302.224	1603.241	7.673	0.00%	KWH
mBinary.Mar	3496501.196	1163149.813	3.006	0.32%	
mBinary.Aug	6367769.780	1332110.256	4.780	0.00%	
IND_Sales.PrevCalib	1804.162	135.483	13.317	0.00%	
IND_Sales.AutoCalib	96.037	28.597	3.358	0.11%	
IND_Sales.CalibCCB	3073514.279	1194319.228	2.573	1.13%	
mBinary.CalibCov	-25495208.999	3932386.461	-6.483	0.00%	
IND_Sales.Nov12	-12570823.606	3845114.750	-3.269	0.14%	
IND_Sales.Jun13toJun14	4226537.492	1401441.130	3.016	0.31%	
IND_Sales.Jul15	11449867.504	3911190.818	2.927	0.41%	
IND_Sales.Nov18	13037461.763	3917049.667	3.328	0.12%	
IND_Sales.Jan15	-13480946.342	3945199.547	-3.417	0.09%	
IND_Sales.Jul19	-21973559.556	3942254.242	-5.574	0.00%	
IND_Sales.Sep19	14273643.313	3918942.620	3.642	0.04%	
IND_Sales.Jun20	35184028.316	5002830.285	7.033	0.00%	
MA(1)	0.196	0.093	2.107	3.72%	

Table 24: KS Metro Residential kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_RES	0.513	0.012	44.263	0.00%	kWh/cust
mStrucVars.XCool65_RES	0.734	0.009	80.334	0.00%	kwh/cust
mStrucVars.XOther_RES	1.205	0.013	93.637	0.00%	kWh/cust
RES_AvgUse.Jul11	133.924	27.292	4.907	0.00%	
RES_AvgUse.Aug12	-115.047	28.011	-4.107	0.01%	
RES_AvgUse.Jun16	57.391	27.998	2.050	4.24%	
RES_AvgUse.Jul17	80.824	27.285	2.962	0.37%	
RES_AvgUse.Sep17	72.616	27.980	2.595	1.06%	
RES_AvgUse.CalibCCB	-24.147	12.546	-1.925	5.65%	
mBinary.CalibCov	42.908	17.132	2.505	1.35%	
SMA(1)	0.370	0.089	4.134	0.01%	

Table 25: KS Metro Small GS Commercial kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_SML	0.783	0.030	25.682	0.00%	kWh/Cust
mStrucVars.XCool60_SML	0.658	0.015	43.287	0.00%	kWh/Cust
mStrucVars.XOther_SML	0.213	0.044	4.834	0.00%	kWh/Cust
mBinary.Dec	54.363	13.781	3.945	0.01%	
SML_AvgUse.YR11	-31.337	13.575	-2.308	2.25%	
mBinary.Oct11	-127.026	43.767	-2.902	0.43%	
mBinary.Apr12	-120.950	42.174	-2.868	0.48%	
SML_AvgUse.Mar13	-126.382	42.630	-2.965	0.36%	
mBinary.Oct13	-140.260	42.080	-3.333	0.11%	
mBinary.Jun14	-118.218	42.355	-2.791	0.60%	
SML_AvgUse.Yr15	52.763	14.925	3.535	0.06%	
SML_AvgUse.Dec16	-102.849	44.085	-2.333	2.11%	
SML_AvgUse.Jan17	146.461	42.936	3.411	0.09%	
SML_AvgUse.Apr17	-161.781	42.612	-3.797	0.02%	
SML_AvgUse.Jun17	-110.789	42.480	-2.608	1.01%	
SML_AvgUse.Feb18	131.412	42.786	3.071	0.26%	
mBinary.CalibSml	-342.881	14.746	-23.253	0.00%	
SML_AvgUse.CalibSwitch	0.026	0.001	31.218	0.00%	
SML_AvgUse.CalibCCB	-202.946	13.843	-14.660	0.00%	
SML_AvgUse.CalibCCB2	-139.755	18.437	-7.580	0.00%	
mBinary.CalibCov	-188.518	26.463	-7.124	0.00%	

Table 26: KS Metro Big GS Commercial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_BIG	418.418	18.210	22.978	0.00%	kWh
mStrucVars.XCool60_BIG	495.933	9.581	51.761	0.00%	Kwh
mStrucVars.XOther_BIG	592.585	43.851	13.513	0.00%	kWh
mBinary.May	5259002.300	1313092.979	4.005	0.01%	
mBinary.Jul	-5475353.206	1448295.512	-3.781	0.03%	
BIG_Sales.Calib	-12868964.681	1219830.150	-10.550	0.00%	
BIG_Sales.CalibTrn	2750.984	160.170	17.175	0.00%	
BIG_Sales.CalibBIG	4095535.677	1182824.013	3.463	0.07%	
BIG_Sales.CalibAug16	-5131229.295	1147684.081	-4.471	0.00%	
BIG_Sales.CalibCCB	2392753.438	1281121.157	1.868	6.42%	
BIG_Sales.YR09	-3038764.073	1578531.870	-1.925	5.66%	
BIG_Sales.Mar09	-10214428.056	4064814.959	-2.513	1.33%	
BIG_Sales.YR18	6872524.973	1454357.202	4.725	0.00%	
BIG_Sales.Jun18	-18211268.441	4148974.772	-4.389	0.00%	
BIG_Sales.Sep18	-25355087.265	4148020.225	-6.113	0.00%	
BIG_Sales.FebMar19	12600075.804	3000502.345	4.199	0.01%	
mBinary.CalibCov	-30627529.237	2474831.064	-12.376	0.00%	

Table 27: KS Metro Industrial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
CONST	8698322.952	912784.405	9.529	0.00%	
mStrucVars.XCool_IND	4533.871	167.101	27.133	0.00%	kWh
mStrucVars.XOther_IND	3423.812	251.292	13.625	0.00%	kWh
IND_Sales.Nov06	2113711.437	587808.424	3.596	0.04%	
IND_Sales.Oct08	1366253.735	587062.026	2.327	2.12%	
IND_Sales.Jan09	-1680908.090	590518.994	-2.846	0.50%	
mBinary.Feb10	4111587.049	609119.619	6.750	0.00%	
mBinary.Jun10	-1758144.897	587961.578	-2.990	0.32%	
mBinary.Aug10	1358842.622	592343.914	2.294	2.31%	
IND_Sales.Oct13	1932347.602	588051.248	3.286	0.13%	
IND_Sales.TrendBefYr14	-53.213	6.251	-8.513	0.00%	
IND_Sales.BeforeMay18	3425907.951	303006.748	11.306	0.00%	
IND_Sales.May18	1171018.599	611015.295	1.917	5.71%	
IND_Sales.Aug18	1950064.791	596455.986	3.269	0.13%	
mBinary.Feb	720408.399	161956.130	4.448	0.00%	
mBinary.CalibCov	-1539675.229	553546.567	-2.781	0.61%	
AR(1)	0.480	0.076	6.286	0.00%	

3. Assessment of the applicability of any load forecast models or portions of models that were utilized by the utility but developed by others, including a specification of the functional forms of any equations or models, to the extent they are available.

The load forecasting models rely on a forecast of economic activity for the KC metro area that was produced by Moody's Analytics. The KC metro area is the same as the Metropolitan Statistical Area (MSA) defined by the US Census Bureau and it includes some counties in both states that are not served by Evergy Metro. Also, Evergy Metro's service area includes some counties that are not included in the MSA. Despite these inconsistencies in geographic areas, there are reasons why this forecast is representative of our service areas. Many people live on one side of the state line and work on the other side. Many people shop on both sides of the state line. And many companies each year move from one side of the state line to the other. Documentation for Moody's forecast of economic activity is provided in the workpapers in the folder Evergy Metro\Models\KCPL Base Case\Data\Economics.

The load forecasting models also rely on saturation and appliance and equipment utilization forecasts from the DOE. The advantages of the projections from these models is 1) DOE's Forecasting and Analyst staff includes dozens of experts and maintains a large budget for data collection and consultants, 2) DOE has a focus on measuring the impacts of appliance and equipment standards and legal mandates and 3) DOE is very transparent, making available its work and computer code on its website.[v] Evergy Metro also relies on the staff that developed and maintained some of EPRI's end-use models recommended and developed the SAE approach for Evergy Metro and many other utilities. EPRI no longer maintains its end-use forecasting models.

A potential downside of these projections for Evergy Metro is that the data and models developed by DOE are developed at a regional level rather than specifically for Evergy Metro, although this can be an advantage when one service area or region has insufficient variation to measure the impact of a variable such as electric price. Cross sectional variation in the data can be an advantage in situations where price or income elasticities are being modeled.

(B) If the utility selects load forecast models that include end-use load methods, the utility shall describe and document any deviations in the independent variables or functional forms of the equations from those derived from load analysis in sections (3) and (4).

Adjustment

(C) Historical Database for Load Forecasting. In addition to the load analysis database, the utility shall develop and maintain a database consistent with and as needed to run each forecast model utilized by the utility. The utility shall describe and document its load forecasting historical database in the triennial compliance filings. As a minimum, the utility shall—

1. Develop and maintain a data set of historical values for each independent variable of each forecast model. The historical values for each independent variable shall be collected for a period of ten (10) years, or such period deemed

sufficient to allow the independent variables to be accurately forecasted over the entire planning horizon;

The independent variables acquired from Moody’s are available back to 1990. Historical economic and demographic data are updated each time Evergy Metro acquires a new forecast as revisions are common.

The independent variables acquired from DOE are available starting in 1995; as in the case of economic data, these historical estimates are subject to revision and are updated each time Evergy Metro receives data with an updated forecast. New studies or data can revise historical estimates of efficiencies and saturations.

Temperature data is maintained back to 1971 for the Kansas City International Airport.

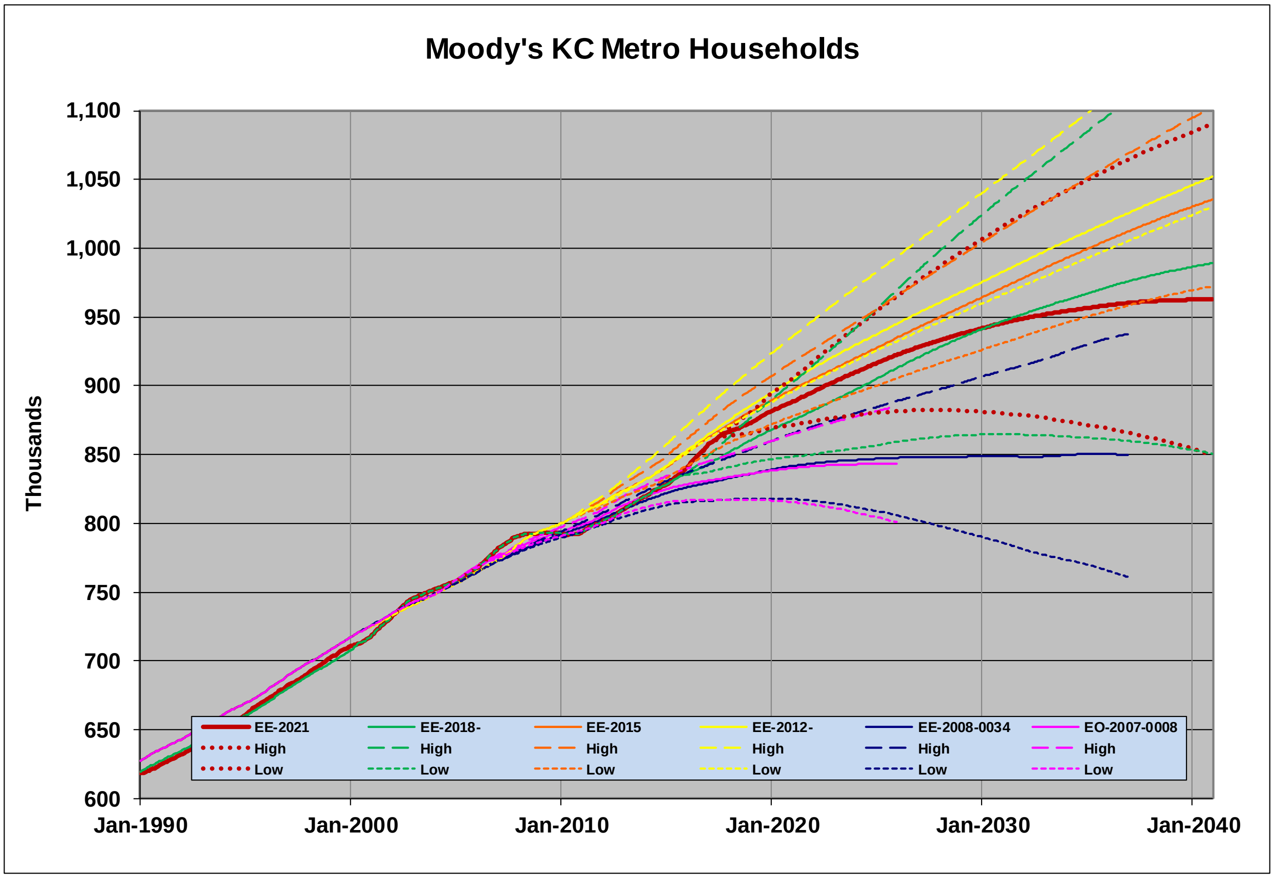
2. Explain any adjustments that it made to historical data prior to using it in its development of the forecasting models;

Evergy Metro staff is not aware of any adjustments made to independent variables used in its load forecasting models.

3. Archive previous projections of all independent variables used in the energy usage and peak load forecasts made in at least the past ten (10) years and provide a comparison of the historical projected values in prior plan filings to actual historical values and to projected values in the current compliance filing; and

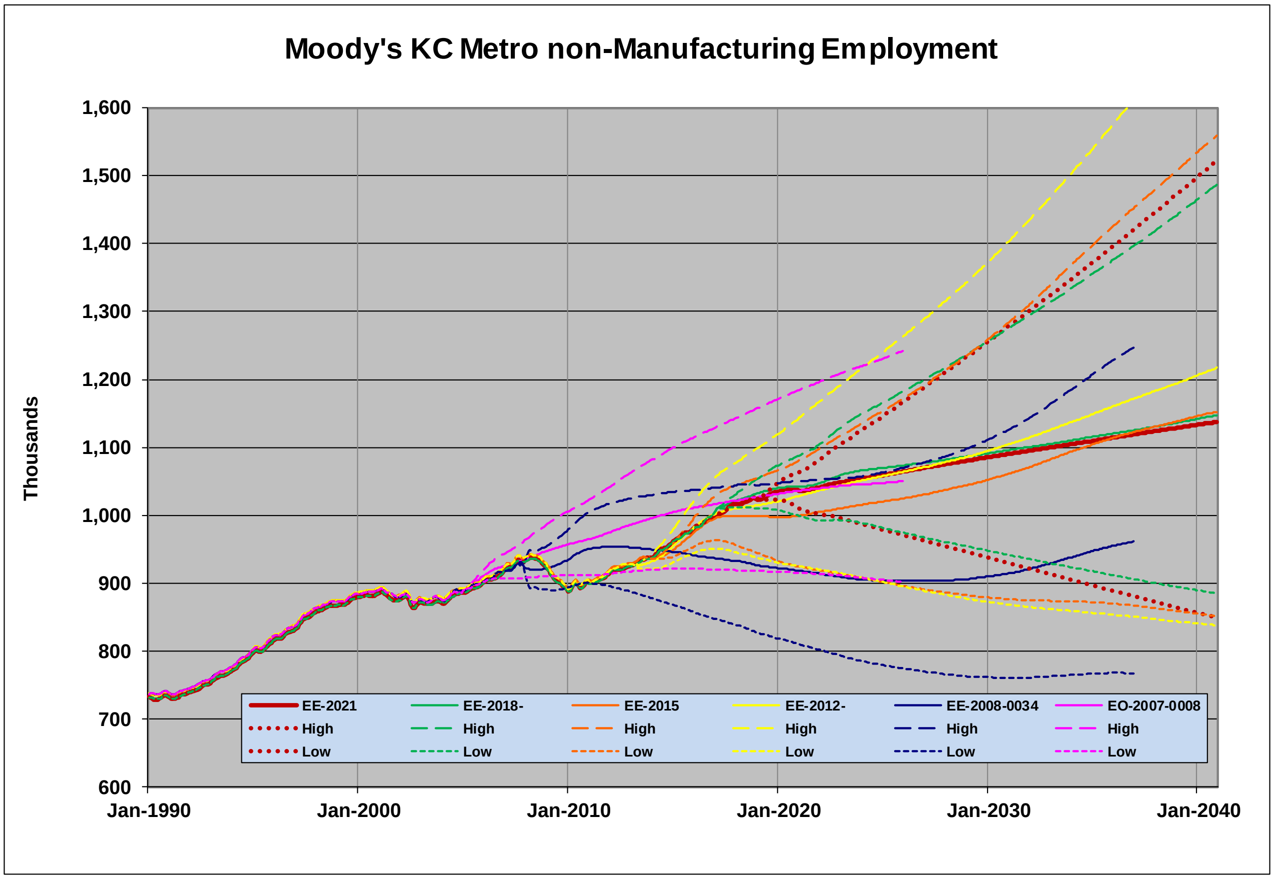
Evergy Metro still possesses the electronic files that it received with the independent variables used in producing energy and peak forecasts during the last ten years. Below we plot the base, high and low bands for the most important economic and demographic independent variables used in recent IRP filings.

Figure 23: Households



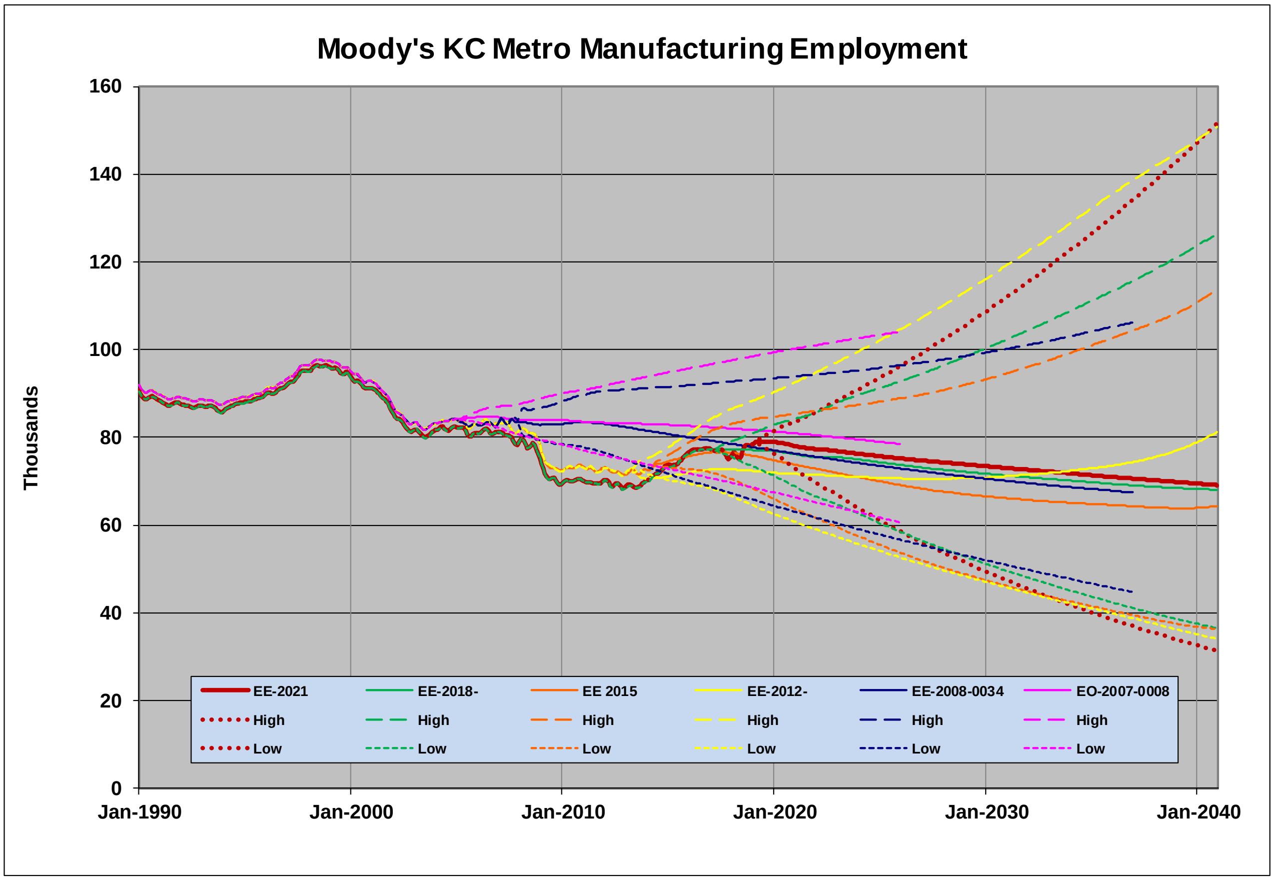
The current forecast for households has a slower long-term growth rate than the prior forecast after recent years has been higher than the last forecast.

Figure 24: Employment Non-Manufacturing



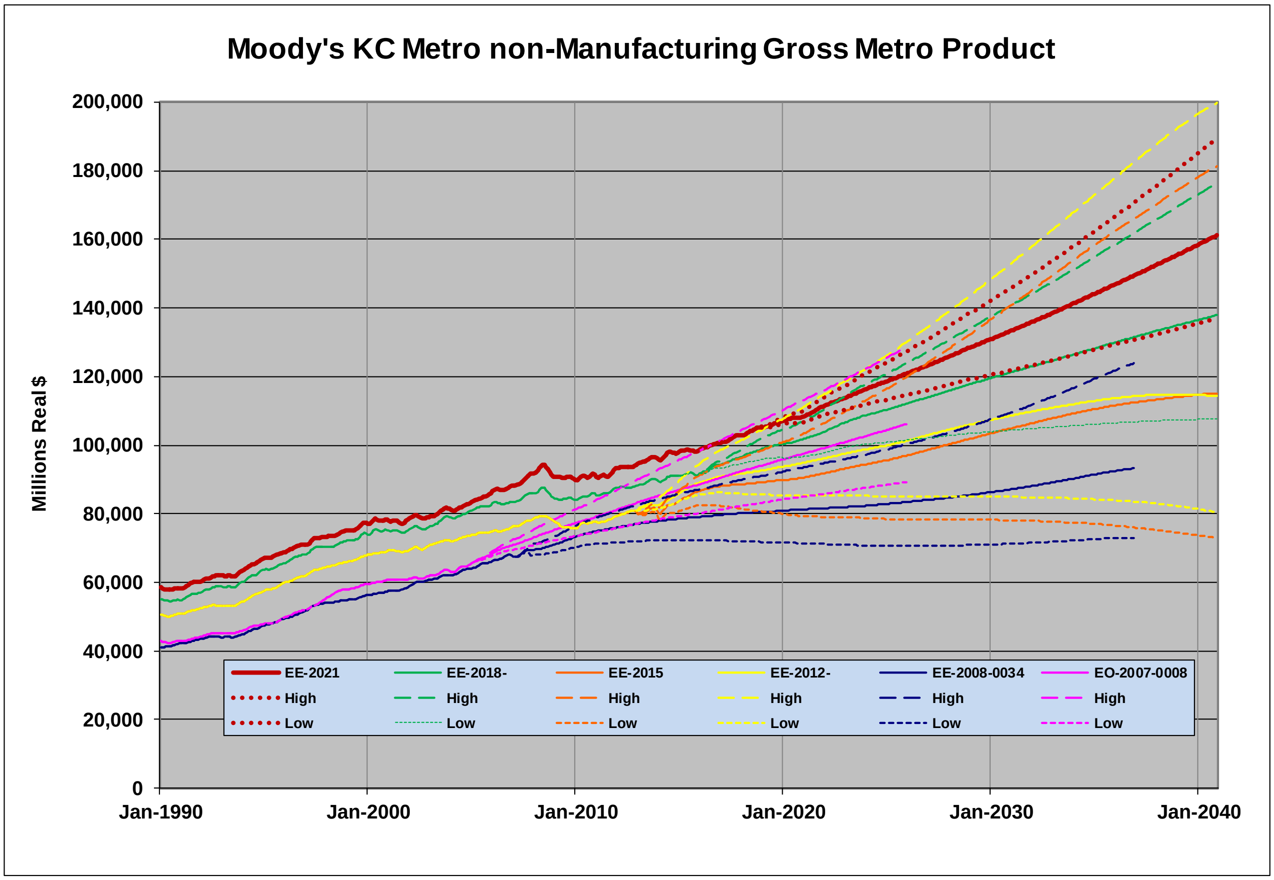
The 2021 forecast of non-manufacturing employment shows growth very similar to the 2018 forecast.

Figure 25: Employment Manufacturing



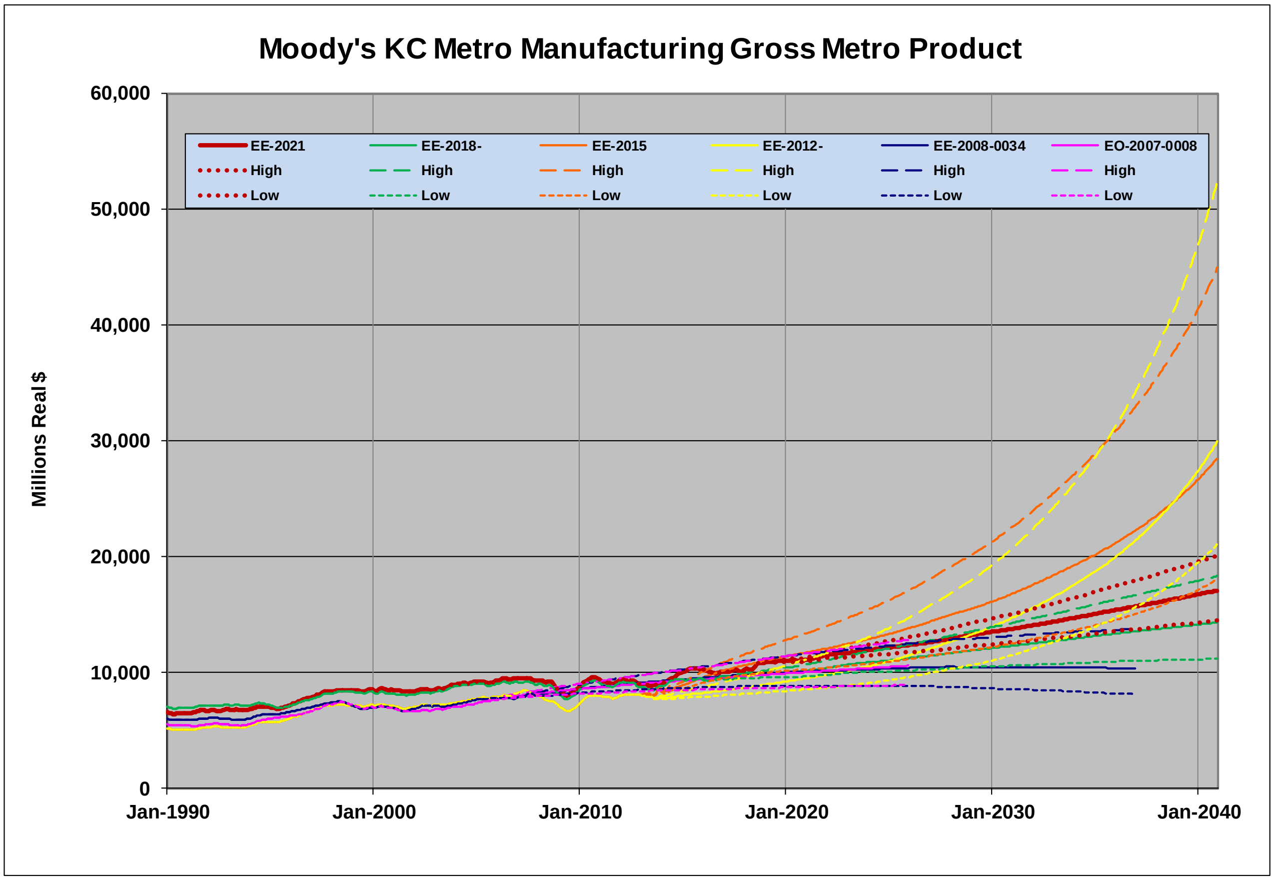
Manufacturing employment shows a large decline following the 2008 recession. It has climbed from a 2013 low and is projected to slowly decline throughout the forecast period very similar to the 2018 forecast despite the last couple years being slightly higher than forecasted. Moody's indicates that the decline in employment for manufacturing workers is due to increased productivity from the workers, as manufacturing becomes more automated. The decline in manufacturing employment for the forecast horizon is also consistent with the observed downward trend dating back to the 1990s.

Figure 26: Gross Metro Product Non-Manufacturing



Real non-manufacturing GMP is growing much faster than employment in all three scenarios. The current forecast is higher than previously forecasted due to revised historical figures; the positive growth trajectory is similar in the short-term, but faster in the long-term.

Figure 27: Gross Metro Product Manufacturing



The current forecast for Manufacturing Gross Metro Product shows slow growth throughout the forecast period, though slightly faster than the 2018 forecast. Some previous Economic forecasts showed rapid growth for two reasons: (1) growth in manufacturing employment in the long run and (2) a competitive advantage for the area in manufacturing leading to faster growth compared to the national average. In contrast, the current forecast has a continuous decline in manufacturing employment and a production growth trajectory are similar to the US as a whole. These assumptions lead to modest growth throughout the forecast period for real manufacturing GMP, as opposed to the previous rapid growth in the long-term.

4. Archive all previous forecasts of energy and peak demand, including the final data sets used to develop the forecasts, made in at least the past ten (10) years. Provide a comparison of the historical final forecasts to the actual historical energy and peak demands and to the current forecasts in the current triennial compliance filing.

Evergy Metro maintains an archive of the electronic files associated with our previous forecasts of energy use and peak demand for at least the last ten years. The graphs below compare our previous long-run forecasts of NSI and peak demand. The most recent forecast is very similar to the prior four forecasts (starting with 2014) reflecting the significant slowdown in economic growth that began in 2008, expectations for modest economic growth, the impact of currently enforced energy efficiency standards and the anticipated impact of recently enacted energy efficiency standards.

Figure 28: Net System Input (NSI) Historical and Forecasts

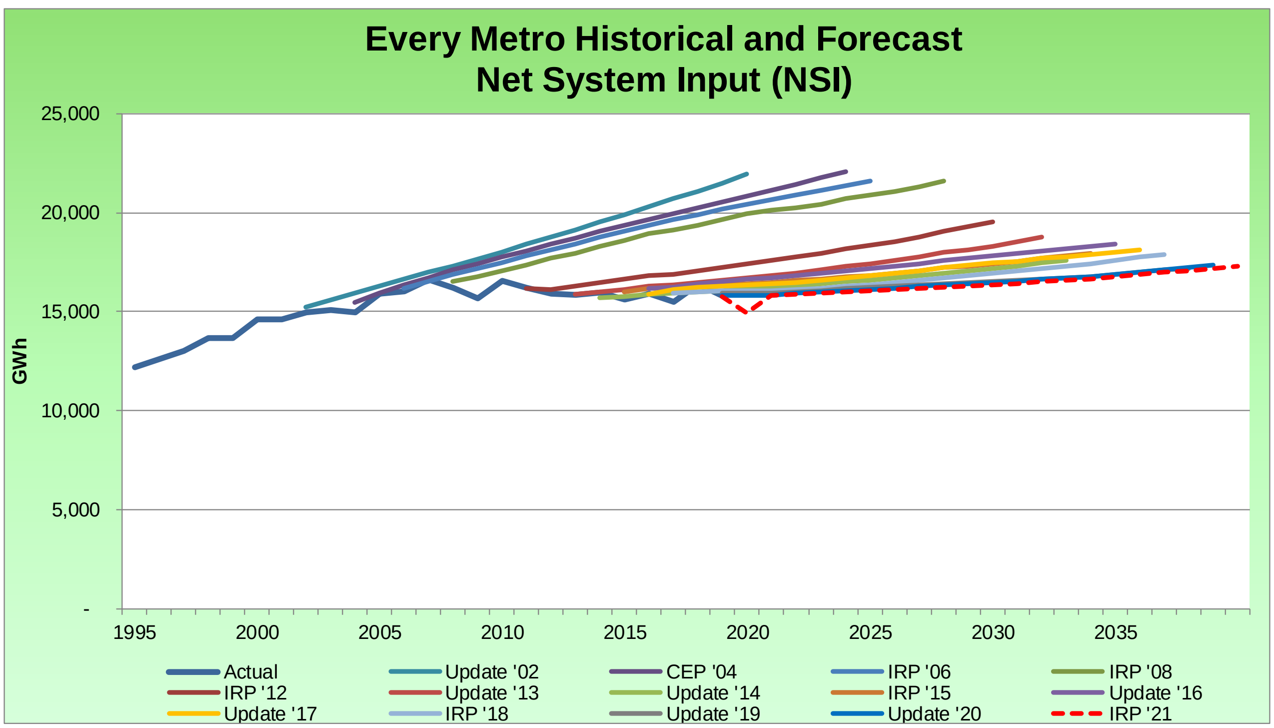
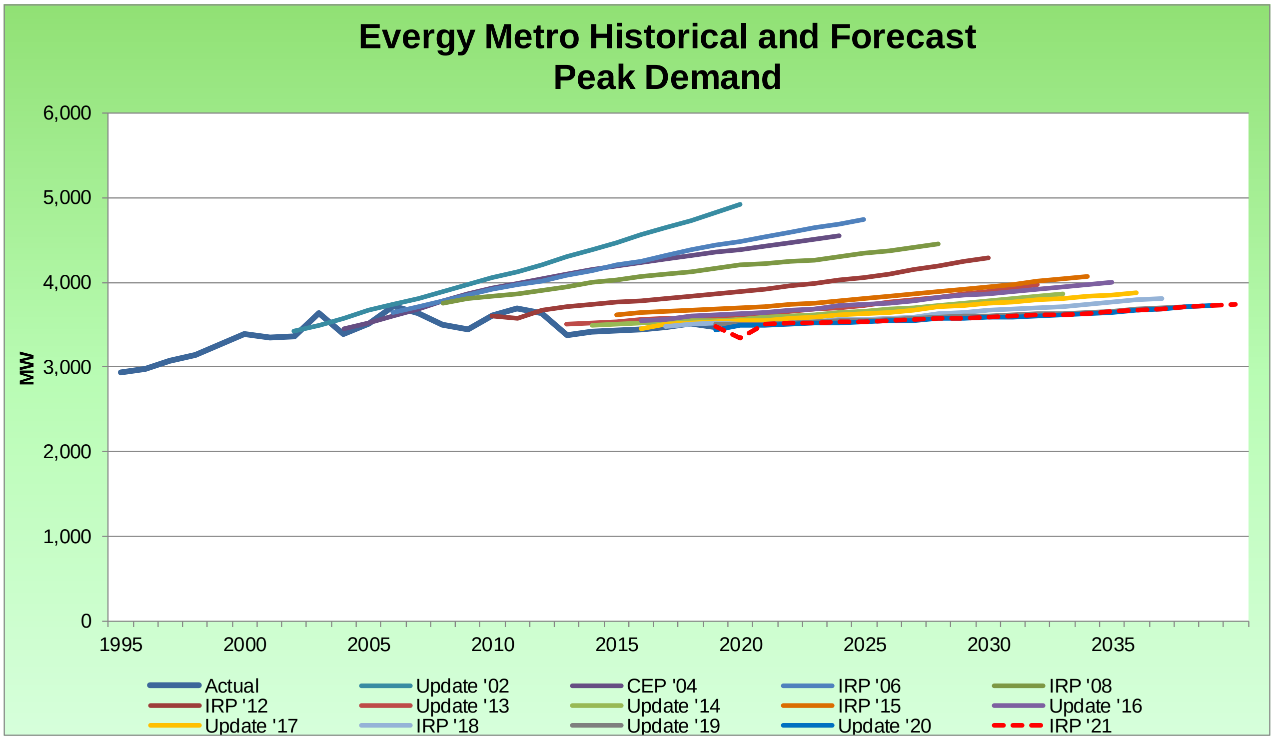


Figure 29: Peak Demand Historical and Forecasts



SECTION 7: BASE-CASE LOAD FORECAST

The utility's base-case load forecast shall be based on projections of the independent variables that utility decision-makers believe to be most likely. All components of the base-case load forecast shall assume normal weather conditions. The load impacts of implemented demand-side programs and rates shall be incorporated in the base-case load forecast, but the load impacts of proposed demand-side programs and rates shall not be included in the base-case forecast.

Evergy Metro's base-case forecast was produced with a base-case economic forecast from Moody's Analytics obtained in June 2020. The forecast included the impacts of Evergy Metro's implemented energy efficiency and DSM programs on NSI and peak load. The forecast was produced using normal weather.

7.1 MAJOR CLASS AND TOTAL LOAD DETAIL

(A) Major Class and Total Load Detail.

The utility shall produce forecasts of monthly energy usage and demands at the time of the summer and winter system peaks by major class for each year of the planning horizon, and shall describe and document those forecasts in its triennial compliance filings. Where applicable, these major class forecasts shall be separated into their jurisdictional components.

7.1.1 DESCRIBE AND DOCUMENT RELEVENT ECONOMIC AND DEMOGRAPHICS

1. The utility shall describe and document how the base-case forecasts of energy usage and demands have taken into account the effects of real prices of electricity, real prices of competitive energy sources, real incomes, and any other relevant economic and demographic factors. If the methodology does not incorporate economic and demographic factors, the utility shall explain how it accounted for the effects of these factors.

Evergy Metro accounted for the effects of real electricity prices in two ways. First, the prices of electricity and natural gas are incorporated into the Energy Information Administration forecast of electric space heat saturation, which are calibrated to Evergy Metro service territory electric space heat saturation to forecast residential and commercial electric space heat customers. These models are described in the section of this document for rule 7.B.1. Second, Evergy Metro assumes a price elasticity of between -0.05 and -0.16 (elasticities vary by customer class) in each model of sales or sales per customer. These elasticities are close to the default values in the ERPI models REEPS and COMEND, which ITRON used in the original SAE models that they delivered to Evergy Metro in 2004. Since, then Evergy Metro has made some small changes to these values to improve the fit of the models.

In the residential models of kWh per customer, Evergy Metro assumes an income elasticity of 0.2 for heating and cooling and 0.2 for other uses and a person's-per-household elasticity of 0.2. Moody's forecast of households for the KC metro area were used in the models of residential customers as was described previously in the section for rule 3.B.

7.1.2 <u>DESCRIBE AND DOCUMENT EFFECTS OF LEGAL MANDATES</u>

2. The utility shall describe and document how the forecasts of energy usage and demands have taken into account the effects of legal mandates affecting the consumption of electricity.

Evergy Metro uses the SAE methodology to forecast kWh sales for residential, commercial, and industrial sales. This methodology relies on DOE forecasts of UECs and EUIs, which account for appliance efficiency standards and building codes.[vi]

7.1.3 <u>DESCRIBE AND DOCUMENT CONSISTENCY</u>

3. The utility shall describe and document how the forecasts of energy usage and demands are consistent with trends in historical consumption patterns, end uses, and end-use efficiency in the utility's service area as identified pursuant to sections 4 CSR 240-22.030(2), (3), and (4).

Evergy Metro forecasts incorporate and thus are consistent with the following trends:

- Electric space heating models explain the rapid rise of electric space heating saturations in the residential and commercial sector as a function of the relative costs of using electricity and natural gas. These costs depend on electricity and natural gas prices and the efficiencies of heat pumps and natural gas furnaces.

- Forecasts of UECs and EUIs used in our models reflect the impacts of energy standards in both the past and the future.

- Forecasts of appliance and equipment saturations reflect the penetration of new devices such as CFL/LED Light Bulbs, HDTVs and the limitations of further increases for appliances that are reaching equilibrium such as dishwashers and central air conditioners.

7.1.4 DESCRIBE AND DOCUMENT WEATHER NORMALIZED CLASS LOADS

4. For at least the base year of the forecast, the utility shall describe and document its estimates of the monthly cooling, heating, and non-weather-sensitive components of the weather-normalized major class loads.

The estimates are shown below. Details for the full 20 years forecast can be found in MetroMO_ClassEndUseWN.ltm and MetroKS_ClassEndUseWN.ltm in the ENDUse_Energy Frequency Transforms.

Figure 30: Estimates of MO Metro Residential Monthly Cooling, Heating, and Base

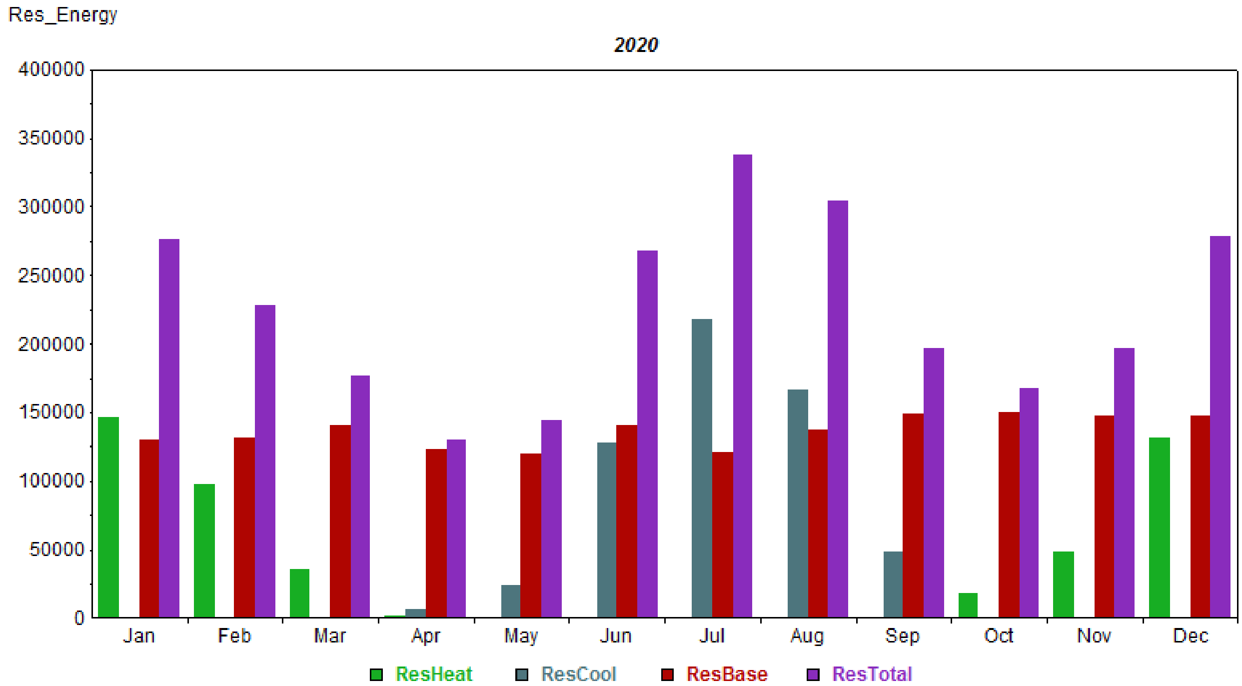


Table 28: Data Table of MO Metro Residential Monthly Cooling, Heating, and Base

Date	ResHeat	ResCool	ResBase	ResTotal
Jan-20	146,055	0	129,969	276,024
Feb-20	97,004	0	131,208	228,211
Mar-20	36,051	377	140,371	176,798
Apr-20	1,716	6,115	122,666	130,497
May-20	8	23,765	120,029	143,802
Jun-20	0	127,577	140,435	268,013
Jul-20	0	217,720	120,663	338,384
Aug-20	0	166,686	136,794	303,480
Sep-20	0	48,903	148,124	197,027
Oct-20	18,102	192	149,316	167,610
Nov-20	48,556	0	147,528	196,084
Dec-20	130,881	0	147,014	277,895

Figure 31: Estimates of MO Metro Commercial Small General Service Monthly Cooling, Heating, and Base

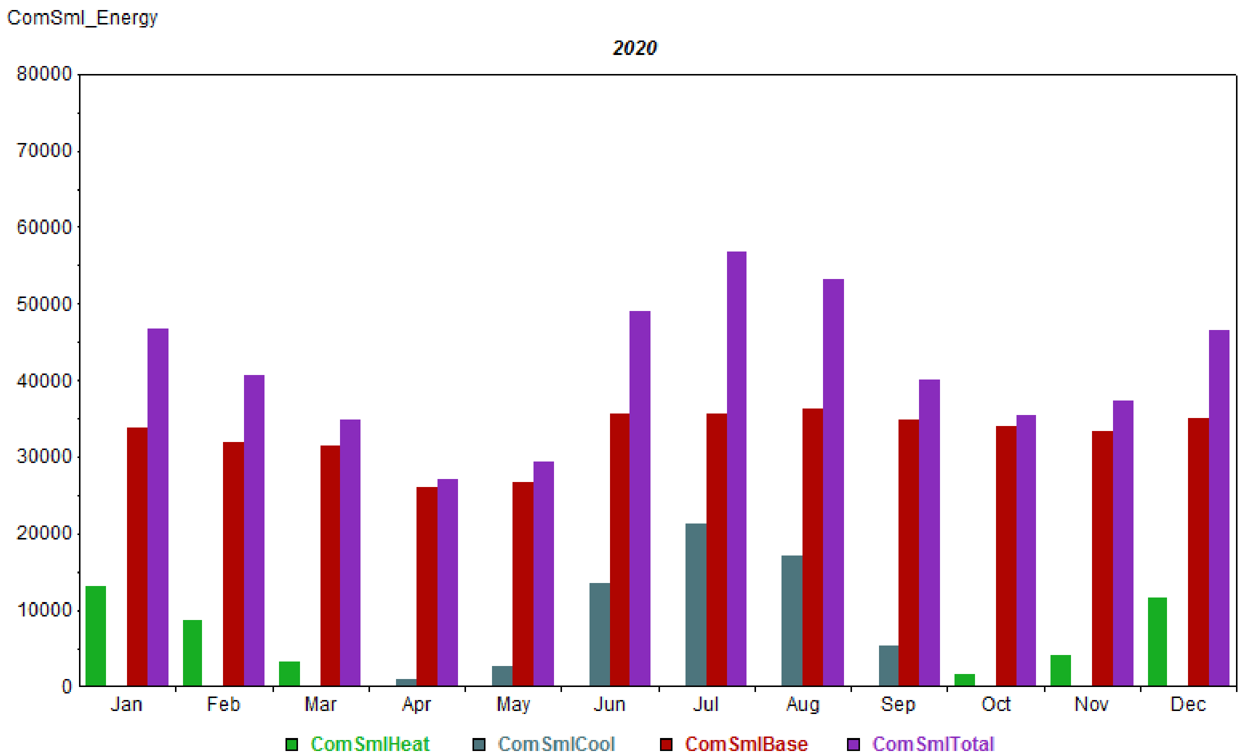


Table 29: Data Table of MO Metro Commercial Small General Service Monthly Cooling, Heating, and Base

Date	ComSmlHeat	ComSmlCool	ComSmlBase	ComSmlTotal
Jan-20	12,978	0	33,754	46,732
Feb-20	8,660	0	31,908	40,568
Mar-20	3,238	50	31,448	34,736
Apr-20	152	858	26,085	27,096
May-20	1	2,588	26,714	29,303
Jun-20	0	13,518	35,586	49,104
Jul-20	0	21,152	35,571	56,723
Aug-20	0	16,951	36,224	53,175
Sep-20	0	5,330	34,718	40,048
Oct-20	1,495	26	33,987	35,509
Nov-20	4,027	0	33,309	37,336
Dec-20	11,597	0	35,003	46,600

Figure 32: Estimates of MO Metro Metro Commercial Big (MGS, LGS & LP) Monthly Cooling, Heating, and Base

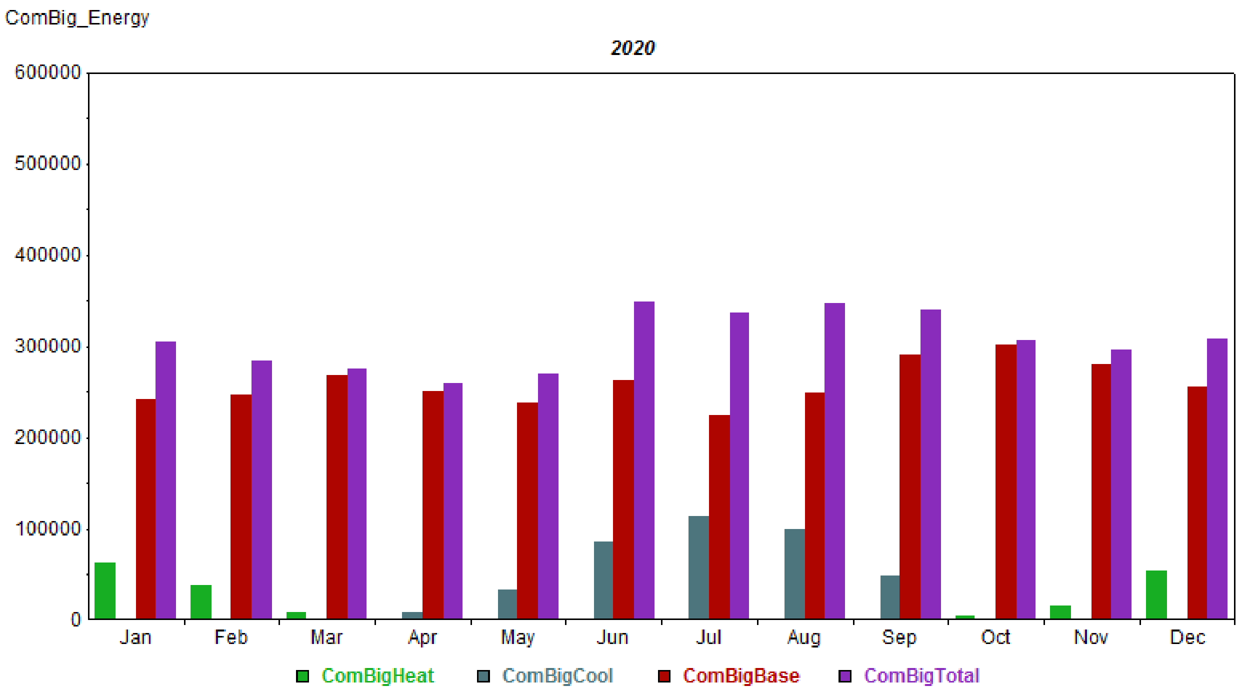


Table 30: Data Table of MO Metro Commercial Big (MGS, LGS & LP) Monthly Cooling, Heating, and Base

Date	ComBigHeat	ComBigCool	ComBigBase	ComBigTotal
Jan-20	61,888	0	242,015	303,904
Feb-20	37,241	0	245,871	283,112
Mar-20	8,376	272	266,891	275,539
Apr-20	34	7,716	250,494	258,245
May-20	0	32,304	238,034	270,338
Jun-20	0	85,877	263,146	349,023
Jul-20	0	113,258	223,722	336,980
Aug-20	0	98,201	248,270	346,472
Sep-20	0	48,343	291,271	339,614
Oct-20	3,932	1,055	301,121	306,107
Nov-20	15,285	0	280,838	296,123
Dec-20	53,095	0	254,777	307,872

Figure 33: Estimates of MO Metro Industrial Monthly Cooling, Heating, and Base

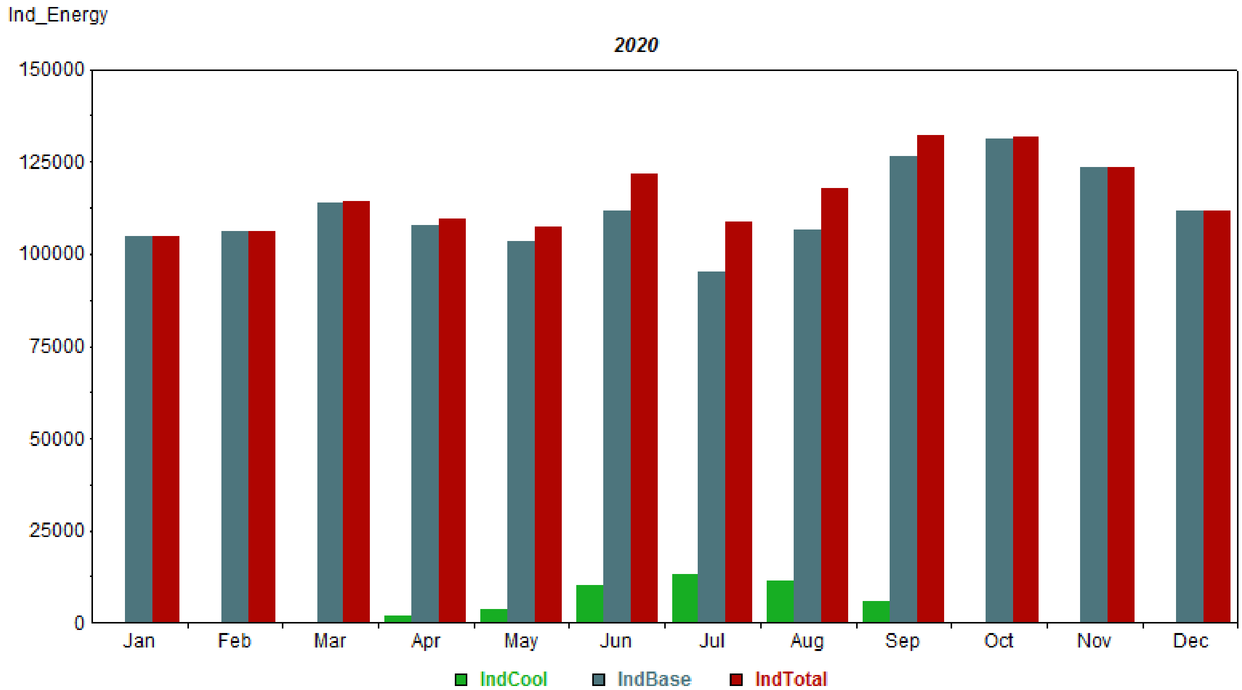


Table 31: Data Table of MO Metro Industrial Monthly Cooling, Heating, and Base

Date	IndCool	IndBase	IndTotal
Jan-20	0	104,765	104,765
Feb-20	0	105,979	105,979
Mar-20	61	114,081	114,141
Apr-20	1,806	107,613	109,420
May-20	3,789	103,419	107,208
Jun-20	10,084	111,807	121,891
Jul-20	13,248	95,232	108,480
Aug-20	11,501	106,342	117,843
Sep-20	5,685	126,412	132,098
Oct-20	131	131,376	131,506
Nov-20	0	123,401	123,401
Dec-20	0	111,646	111,646

Figure 34: Other MO Metro Load (SFR & Lighting)

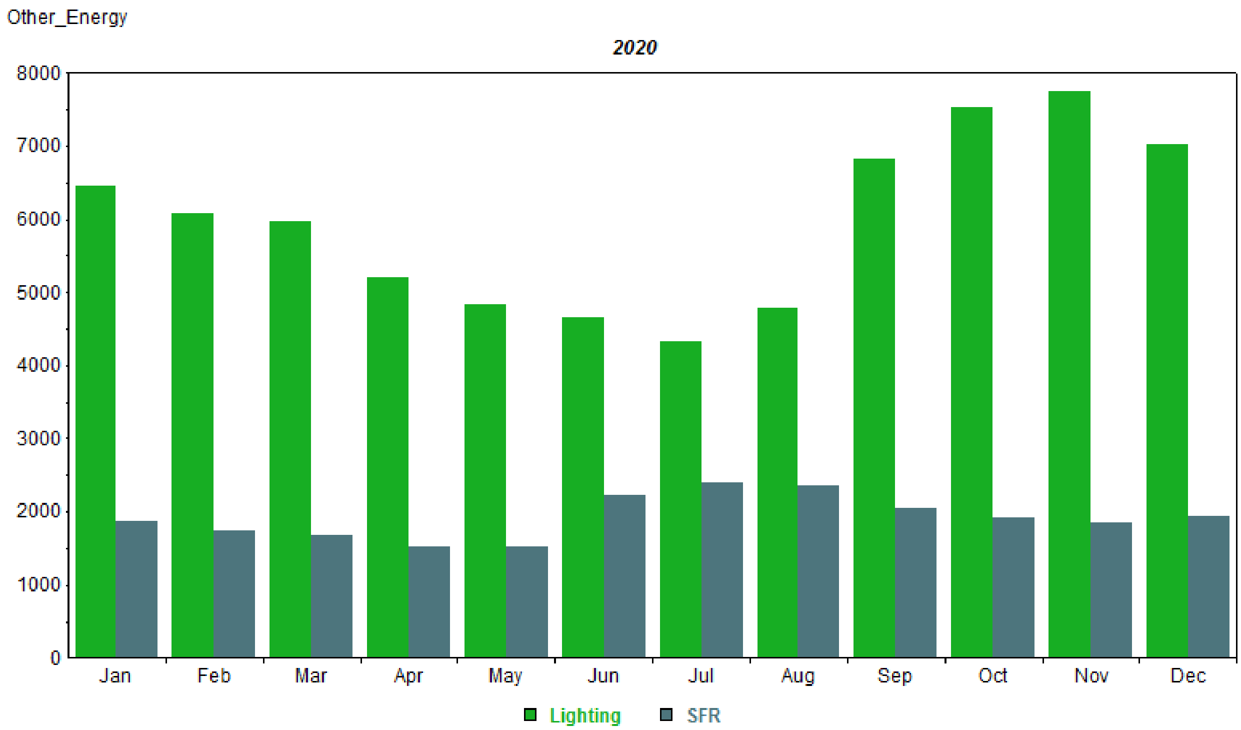


Table 30: Data Table Other MO Metro Load (SFR & Lighting)

Date	Lighting	SFR
Jan-20	6,446	1,881
Feb-20	6,084	1,742
Mar-20	5,967	1,676
Apr-20	5,192	1,529
May-20	4,834	1,525
Jun-20	4,652	2,220
Jul-20	4,312	2,401
Aug-20	4,777	2,344
Sep-20	6,830	2,045
Oct-20	7,533	1,912
Nov-20	7,748	1,852
Dec-20	7,022	1,931

Figure 35: Estimates of KS Metro Residential Monthly Cooling, Heating, and Base

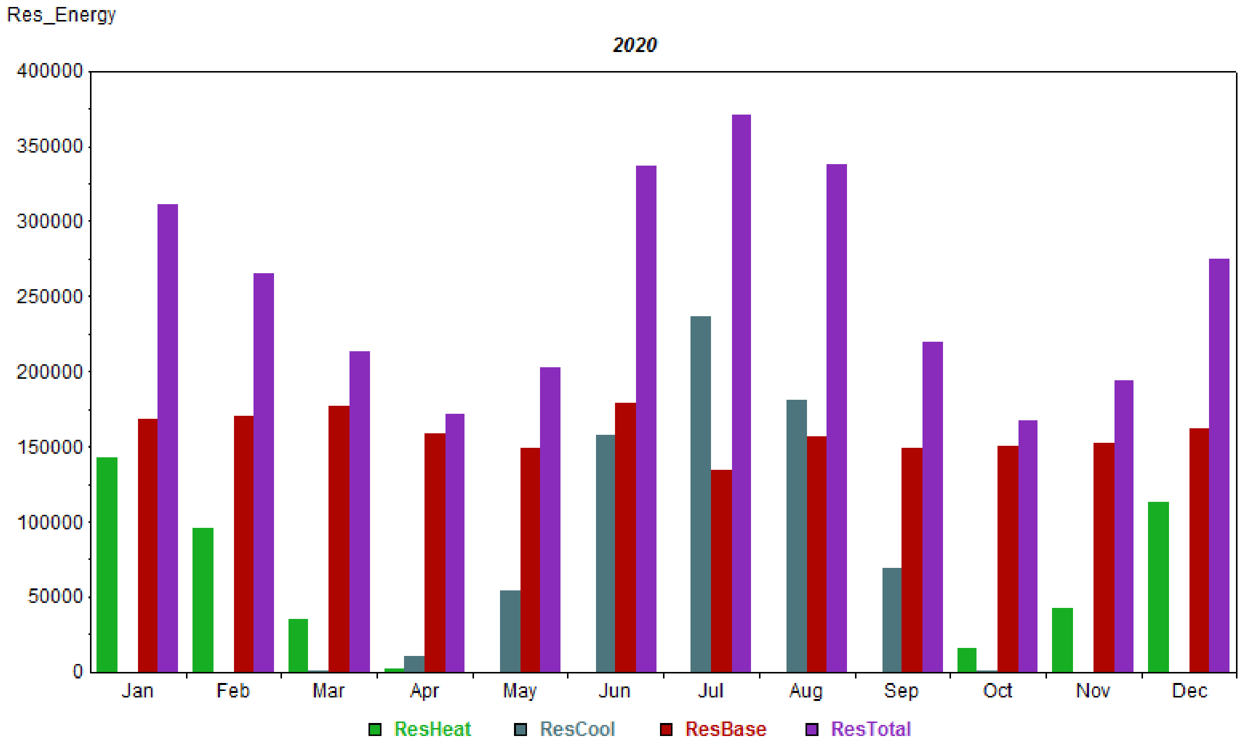


Table 31: Data Table of KS Metro Residential Monthly Cooling, Heating, and Base

Date	ResHeat	ResCool	ResBase	ResTotal
Jan-20	142,559	0	168,656	311,215
Feb-20	95,632	0	169,989	265,620
Mar-20	35,100	391	177,209	212,699
Apr-20	1,807	10,974	158,667	171,448
May-20	8	53,822	148,836	202,666
Jun-20	0	157,431	179,005	336,436
Jul-20	0	236,088	134,288	370,376
Aug-20	0	181,322	156,743	338,065
Sep-20	0	69,706	149,488	219,194
Oct-20	16,181	1,338	149,732	167,250
Nov-20	41,932	0	152,287	194,219
Dec-20	112,554	0	162,000	274,554

Figure 36: Estimates of KS Metro Commercial Small General Service Monthly Cooling, Heating, and Base

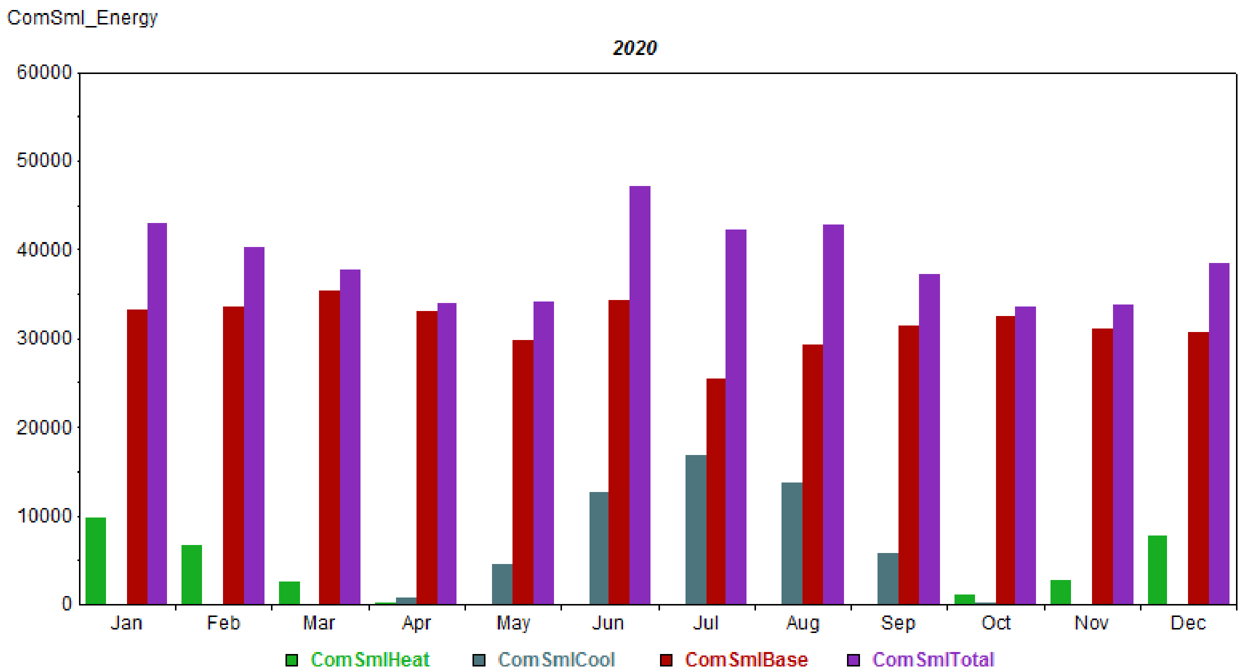


Table 32: Data Table of KS Metro Commercial Small General Service Monthly Cooling, Heating, and Base

Date	ComSmlHeat	ComSmlCoo	ComSmlBas	ComSmlTota
Jan-20	9,800	0	33,196	42,996
Feb-20	6,613	0	33,617	40,230
Mar-20	2,438	29	35,318	37,785
Apr-20	124	779	32,927	33,831
May-20	1	4,512	29,682	34,195
Jun-20	0	12,714	34,341	47,055
Jul-20	0	16,689	25,502	42,191
Aug-20	0	13,723	29,133	42,856
Sep-20	0	5,827	31,357	37,184
Oct-20	1,020	123	32,392	33,536
Nov-20	2,665	0	31,046	33,711
Dec-20	7,722	0	30,655	38,377

Figure 37: Estimates of KS Metro Commercial Big General Service (MGS and LGS) Monthly Cooling, Heating, and Base

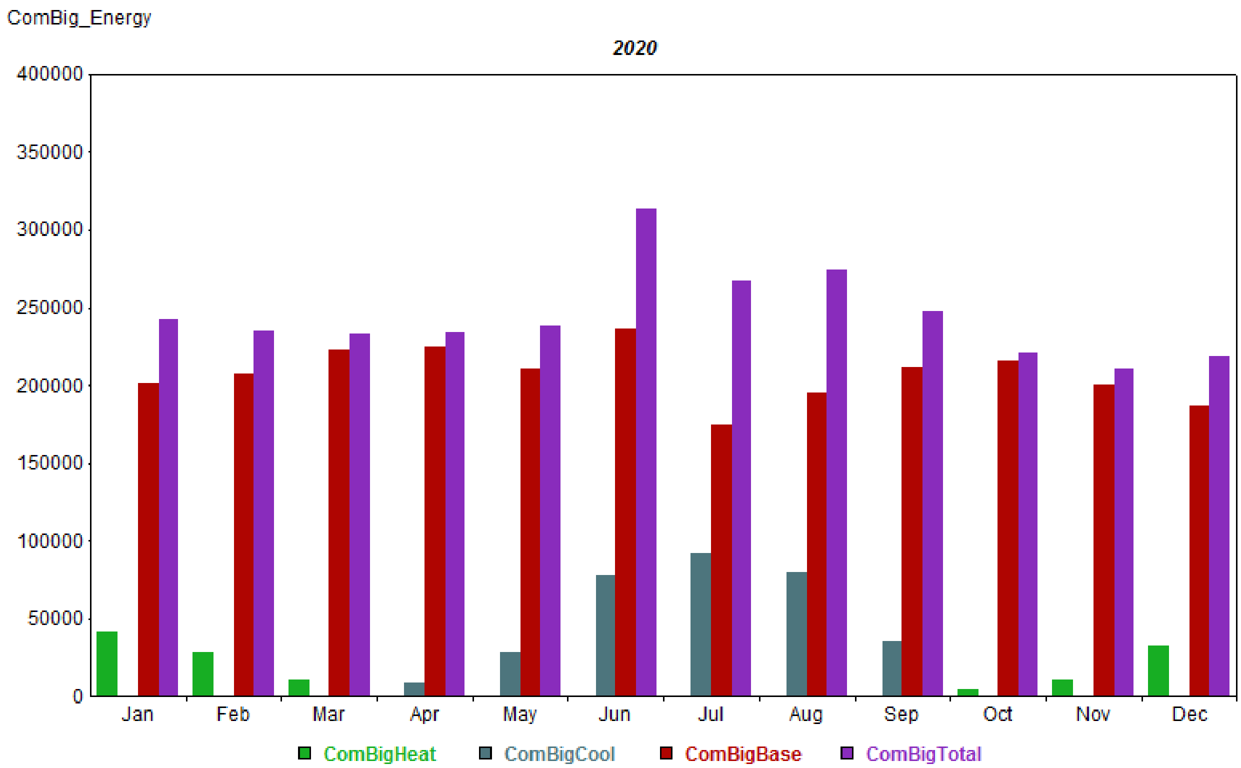


Table 33: Data Table of KS Metro Commercial Big General Service (MGS and LGS) Monthly Cooling, Heating, and Base

Date	ComBigHeat	ComBigCool	ComBigBase	ComBigTotal
Jan-20	41,054	0	201,424	242,477
Feb-20	27,494	0	207,257	234,751
Mar-20	10,159	279	222,715	233,153
Apr-20	521	8,329	224,933	233,783
May-20	3	28,071	209,960	238,034
Jun-20	0	77,202	236,396	313,597
Jul-20	0	92,329	174,326	266,655
Aug-20	0	79,218	195,354	274,572
Sep-20	0	35,603	211,820	247,422
Oct-20	4,192	720	215,644	220,555
Nov-20	11,018	0	199,539	210,556
Dec-20	32,408	0	186,712	219,119

Figure 38: Estimates of KS Metro Industrial Monthly Cooling, Heating, and Base

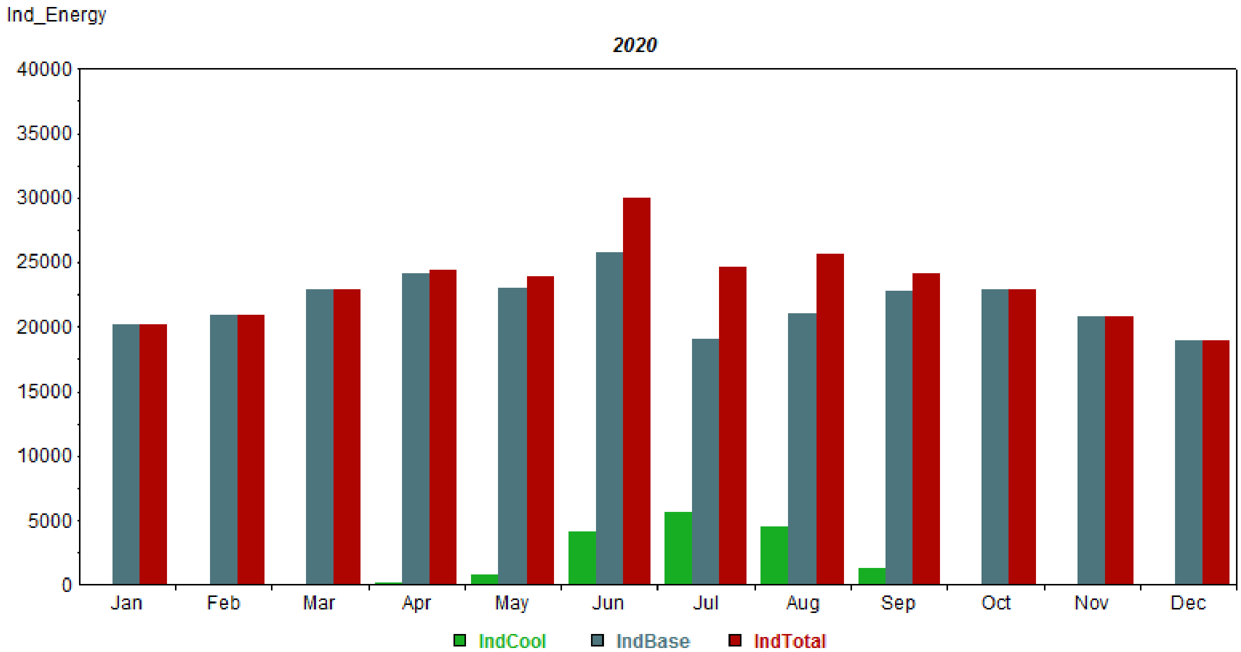


Table 34: Data Table of KS Metro Industrial Monthly Cooling, Heating, and Base

Date	IndCool	IndBase	IndTotal
Jan-20	0	20,161	20,161
Feb-20	0	20,937	20,937
Mar-20	12	22,843	22,855
Apr-20	192	24,196	24,388
May-20	784	23,045	23,830
Jun-20	4,164	25,818	29,982
Jul-20	5,654	18,996	24,650
Aug-20	4,560	21,079	25,639
Sep-20	1,347	22,748	24,095
Oct-20	5	22,883	22,888
Nov-20	0	20,765	20,765
Dec-20	0	18,939	18,939

Figure 39: Other KS Metro Load (Lighting)

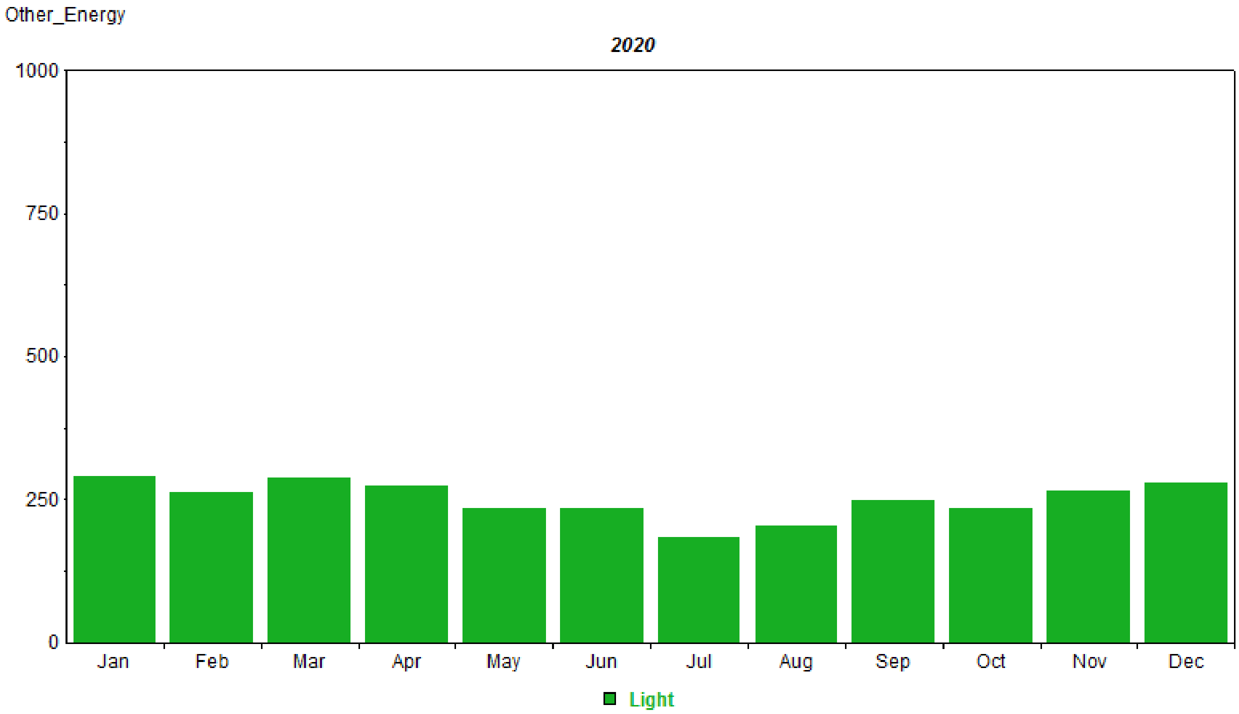


Table 35: Data Table Other KS Metro Load (Lighting)

Date	Light
Jan-20	290
Feb-20	262
Mar-20	287
Apr-20	272
May-20	235
Jun-20	233
Jul-20	182
Aug-20	203
Sep-20	249
Oct-20	235
Nov-20	265
Dec-20	280

Evergy Metro-KS has zero SFR customers as of July 2017.

7.1.5 DESCRIBE AND DOCUMENT MODIFICATION OF MODELS

5. Where judgment has been applied to modify the results of its energy and peak forecast models, the utility shall describe and document the factors which caused the modification and how those factors were quantified.

No outside-the-model modifications were made to the forecasted values resulting from the energy and peak forecast models.

7.1.6 PLOTS OF CLASS MONTHLY ENERGY AND COINCIDENT PEAK DEMAND

6. For each major class specified pursuant to subsection (2)(A), the utility shall provide plots of class monthly energy and coincident peak demand at the time of summer and winter system peaks. The plots shall cover the historical database period and the forecast period of at least twenty (20) years. The plots of coincident peak demands for the historical period shall include both actual and weather-normalized peak demands at the time of summer and winter system peaks. The plots of coincident peak demand for the forecast period shall show the class coincident demands for the base-case forecast at the time of summer and winter system peaks.

Plots for class monthly energy and coincident peak demand at the time of summer and winter system loads are provided in *Appendix 3B*. Energy plots by jurisdiction and system are provided in the file *IRP_7.1.6_Metro_MWh.xlsx* and peak plots are in the file *IRP_7.1.6_Metro_Peaks.xlsx*.

7.1.7 PLOTS OF NET SYSTEM LOAD PROFILES

7. The utility shall provide plots of the net system load profiles for the summer peak day and the winter peak day showing the contribution of each major class. The plots shall be provided in the triennial filing for the base year of the forecast and for the fifth, tenth, and twentieth years of the forecast. Plots for all years shall be included in the workpapers supplied at the time of the triennial filing.

The figures below show the load profiles for the base, fifth, tenth, and twentieth years broken out by summer and winter peak days for each major class in Missouri, Kansas and for the system. The plots with data tables are provided in *Appendix 3C*. Plots for additional years can be found in the MetrixLT files (Metro*MO_ClassEndUse*, Metro*KS_ClassEndUse*, and *SysShape*) included in the workpapers.

Figure 40: Base Year (2020) Net System Load Profiles for MO Metro, KS Metro, and System

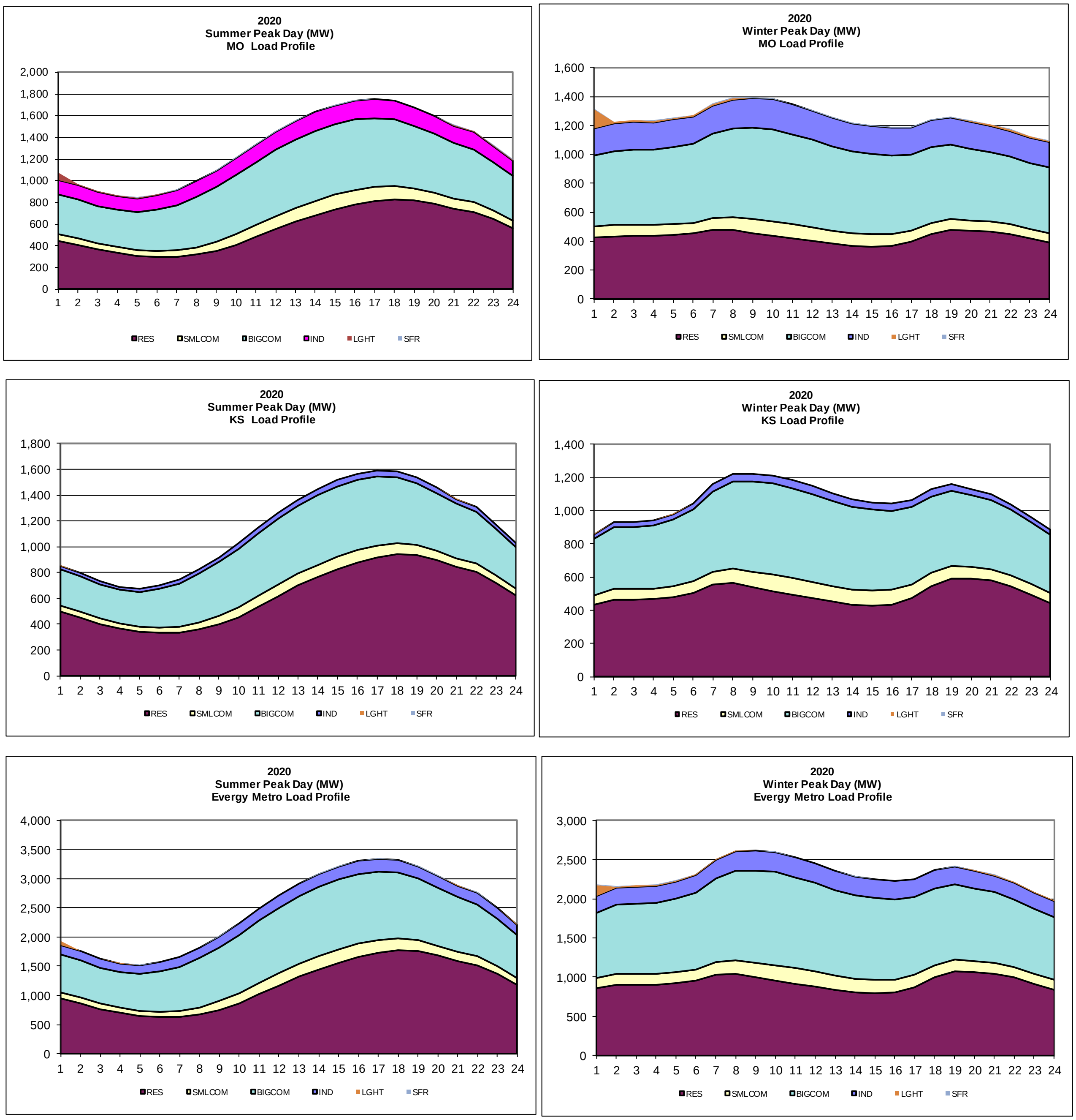
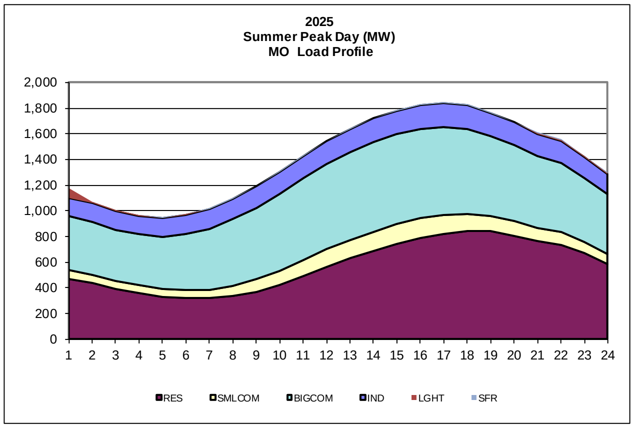
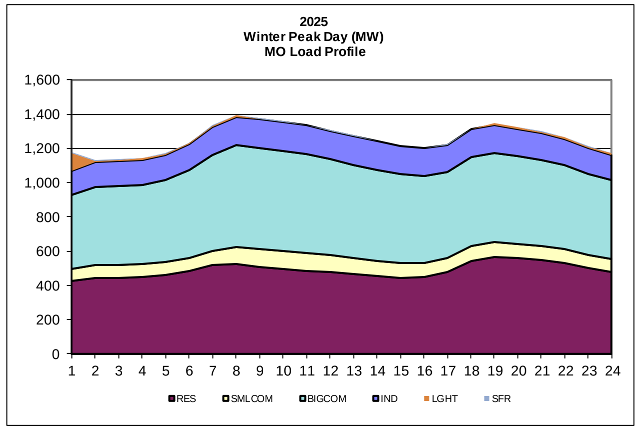
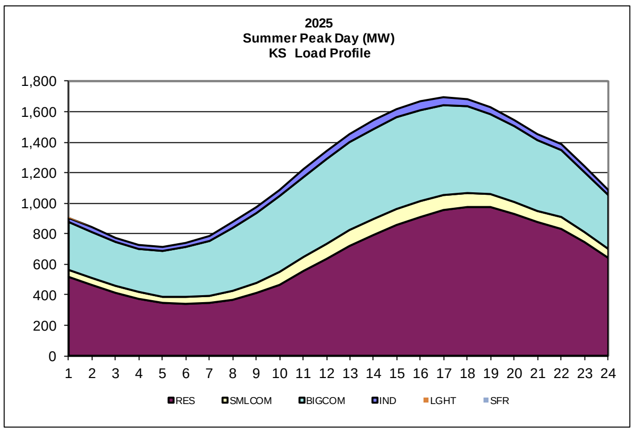
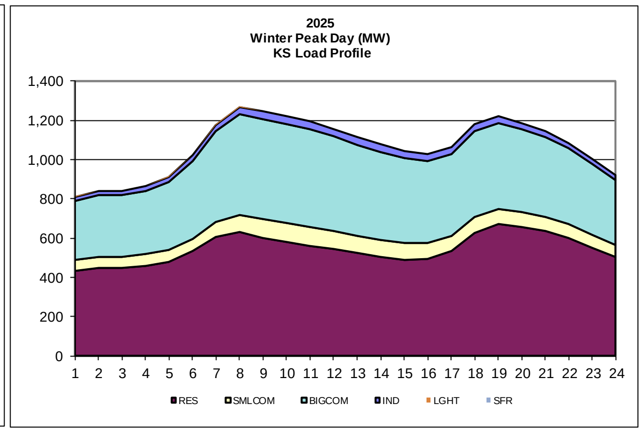


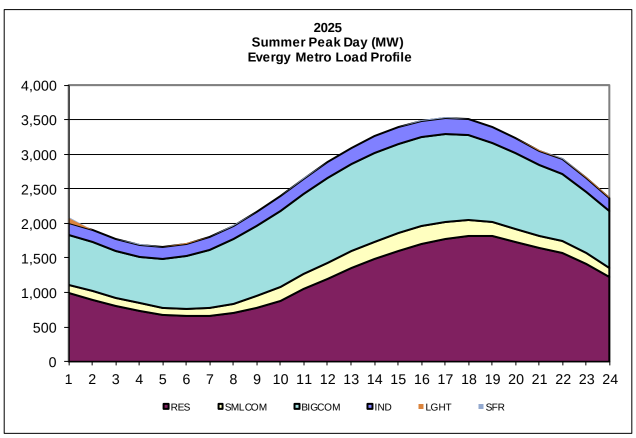
Figure 41: Fifth Year (2025) Net System Load Profiles for MO Metro, KS Metro, and System











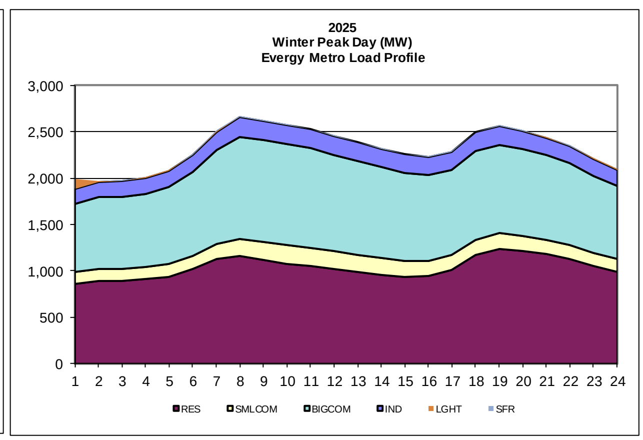
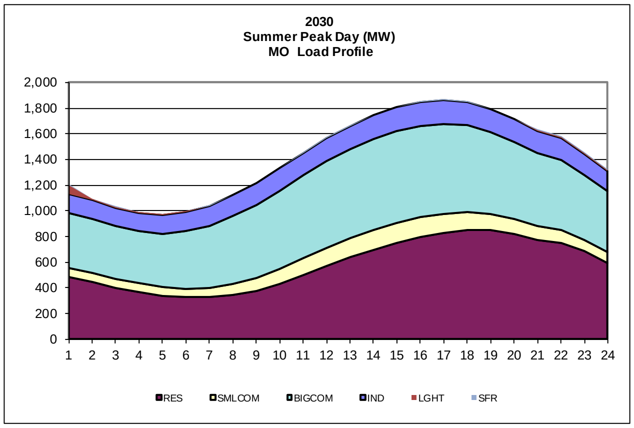
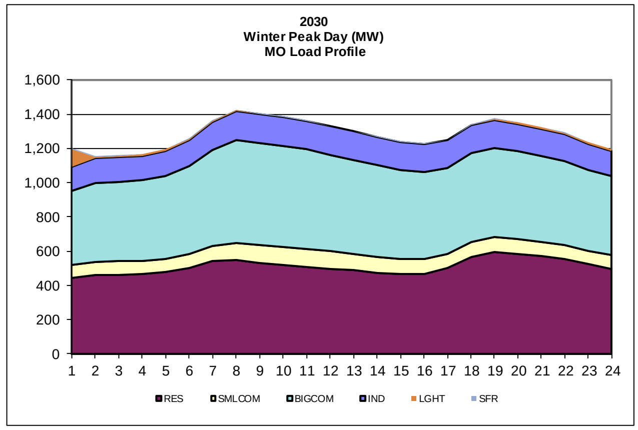
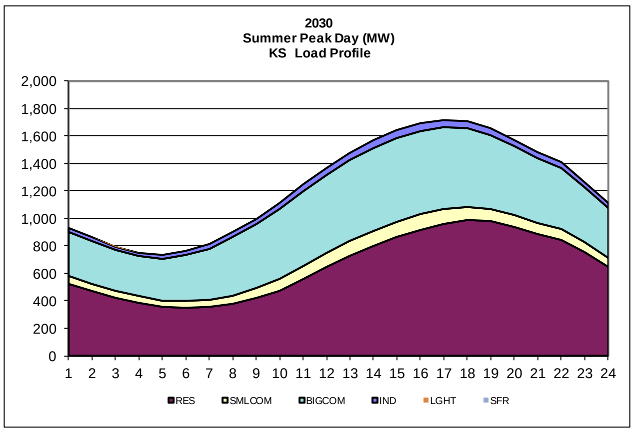
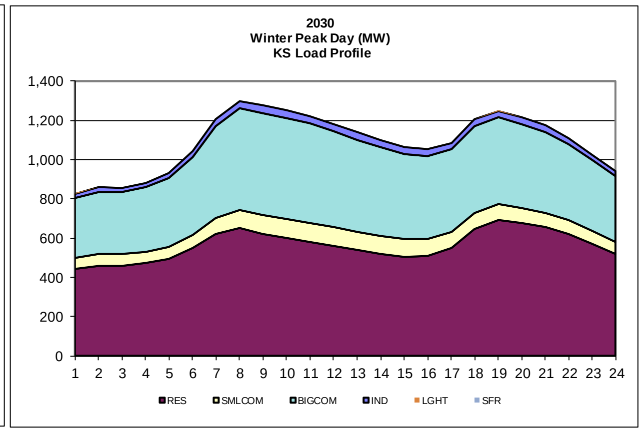


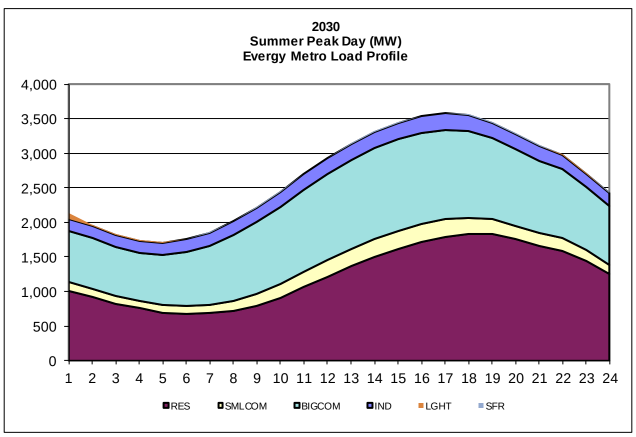
Figure 42: Tenth Year (2030) Net System Load Profiles for MO Metro, KS Metro, and System











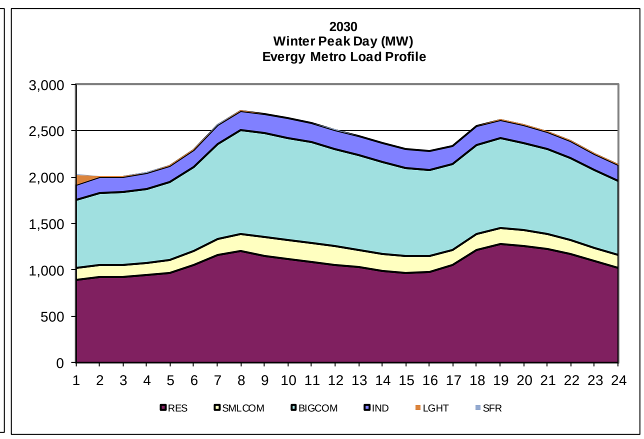
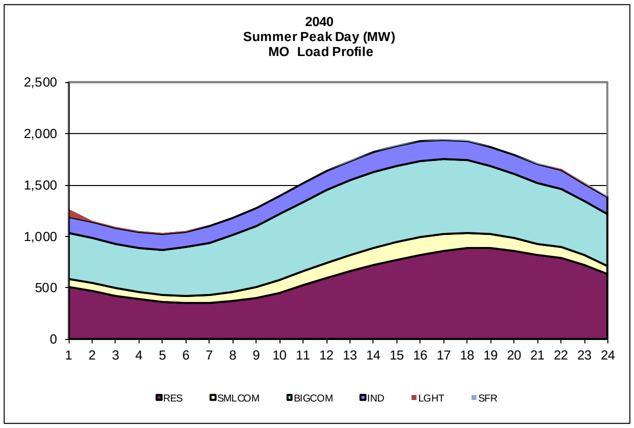
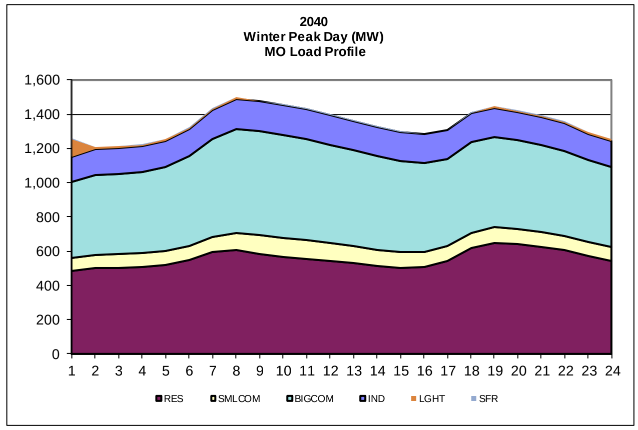
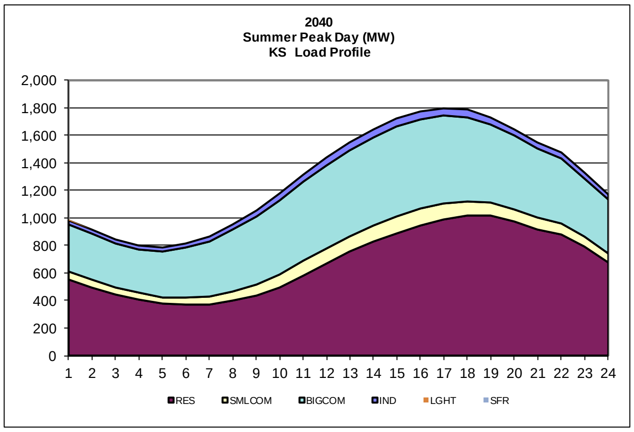
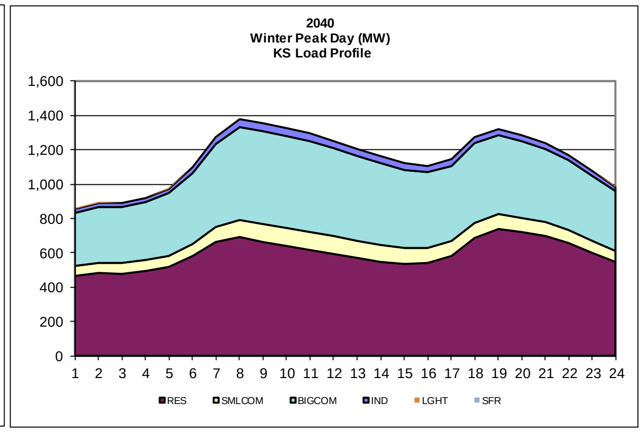


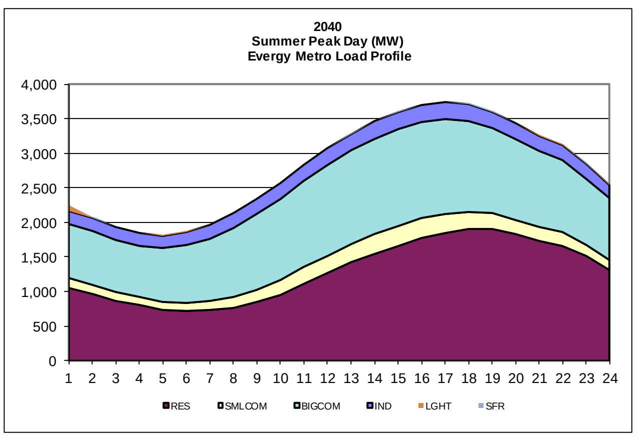
Figure 43: Twentieth Year (2040) Net System Load Profiles for MO Metro, KS Metro, and System

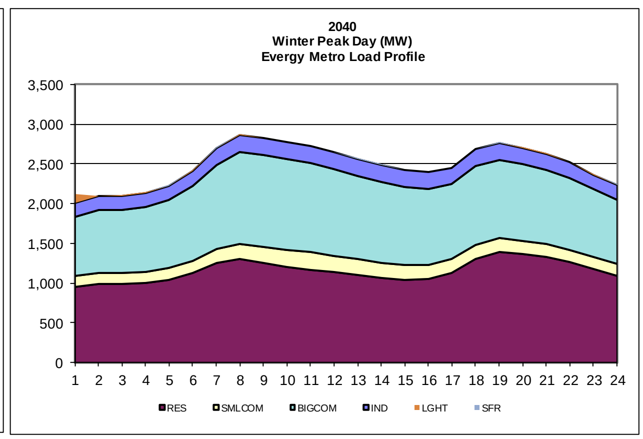












7.2 DESCRIBE AND DOCUMENT FORECASTS OF INDEPENDENT VARIABLES

(B) Forecasts of Independent Variables.

The forecasts of independent variables shall be specified, described, and documented.

The forecasts of independent variables were described above in the section for rule 6.C.3 and below in the section for rule for 7.B.3.

7.2.1 DOCUMENTATION OF MATHEMATICAL MODELS

1. Documentation of mathematical models developed by the utility to forecast the independent variables shall include the reasons the utility selected the models as well as specification of the functional form of the equations.

No mathematical models were developed by the utility to forecast the independent variables.

7.2.2 DOCUMENTATION OF ADOPTED FORECASTS DEVELOPED BY ANOTHER ENTITY

2. If the utility adopted forecasts of independent variables developed by another entity, documentation shall include the reasons the utility selected those forecasts, an analysis showing that the forecasts are applicable to the utility's service territory, and, if available, a specification of the functional form of the equations used to forecast the independent variables.

Evergy Metro used a forecast of economic and demographic variables for the KC metro area that was developed by Moody's Analytics. The reasons for using this forecast, the applicability to Evergy Metro's service area and documentation for the forecast were discussed in the sections for rules 22.030(3)(A) and 22.030(6)(A)3.

Evergy Metro used forecasts of saturations, UECs, EUIs and building efficiencies from DOE. The reasons for using these forecasts, the applicability to Evergy Metro's service area and documentation for the forecast were discussed in the sections for rules 22.030(3)(A), (4)(A)1. 22.030(B), 22.030(5)(A), 22.030(5)(B) and 22.030(6)(A)3.

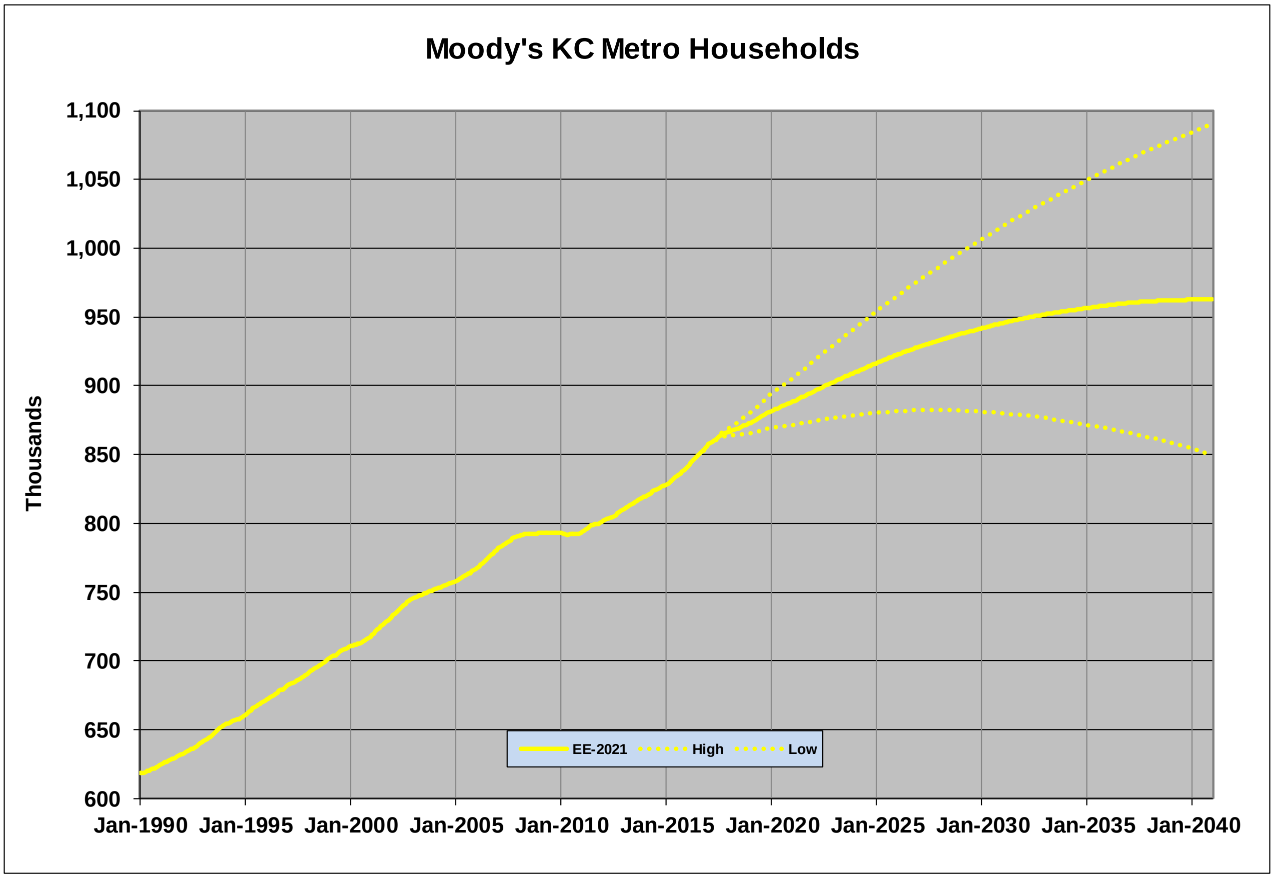
7.2.3 COMPARISON OF FORECAST FROM INDEPENDENT VARIABLES TO HISTORICAL TRENDS

3. These forecasts of independent variables shall be compared to historical trends in the variables, and significant differences between the forecasts and long-term and recent trends shall be analyzed and explained.

Table 36: Economic Growth Rates for KC Metro Area **

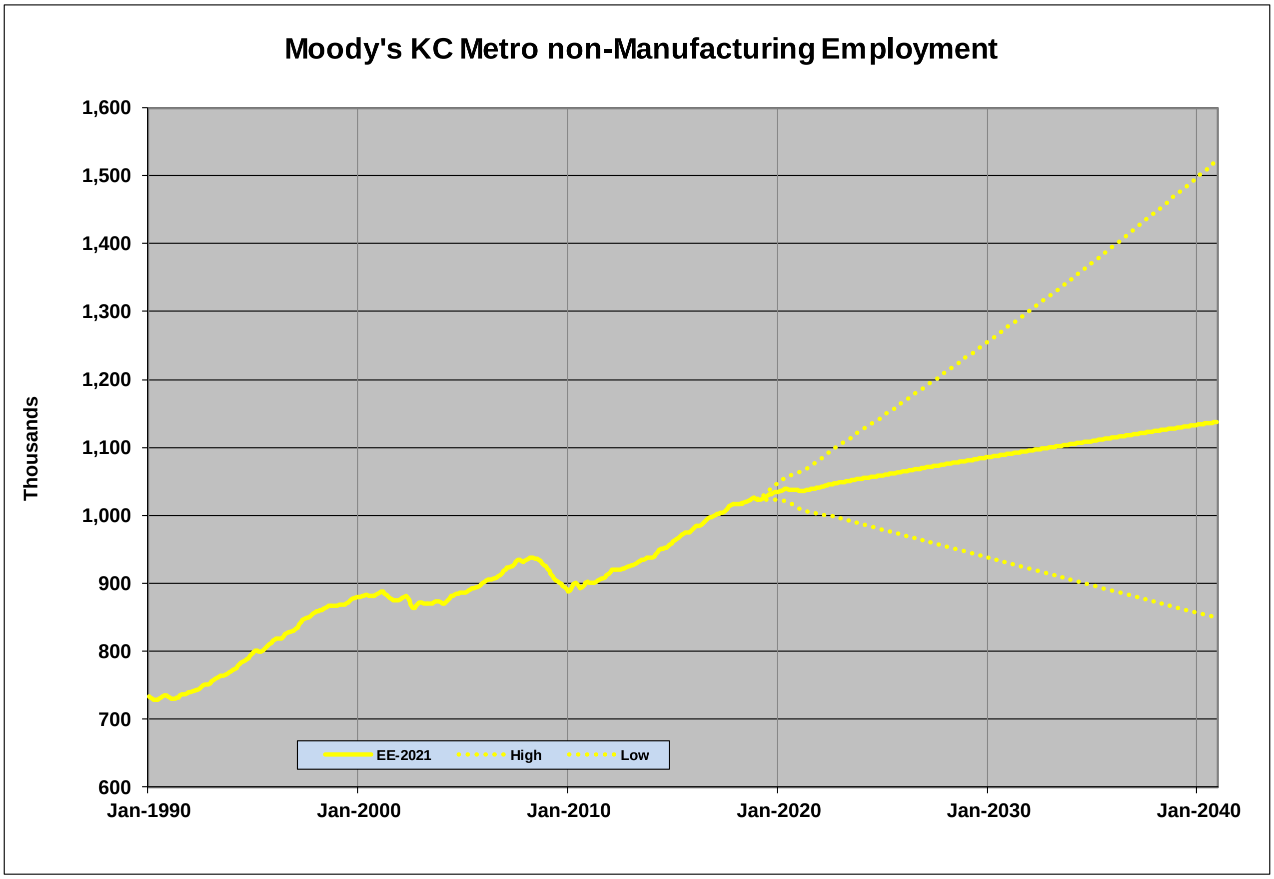
Year	Households	Employment Non-Manufacturing	Employment Manufacturing	Gross Product Non-Manufacturing	Gross Product Manufacturing
2000	1.4%	1.9%	0.3%	3.2%	1.7%
2010	1.1%	0.2%	-2.6%	1.3%	1.1%
2020	1.0%	1.5%	0.8%	1.7%	1.1%
2030	0.5%	0.5%	-0.7%	1.8%	1.9%
2040	0.1%	0.5%	-0.5%	1.3%	1.5%

Figure 44: KC Metro Households



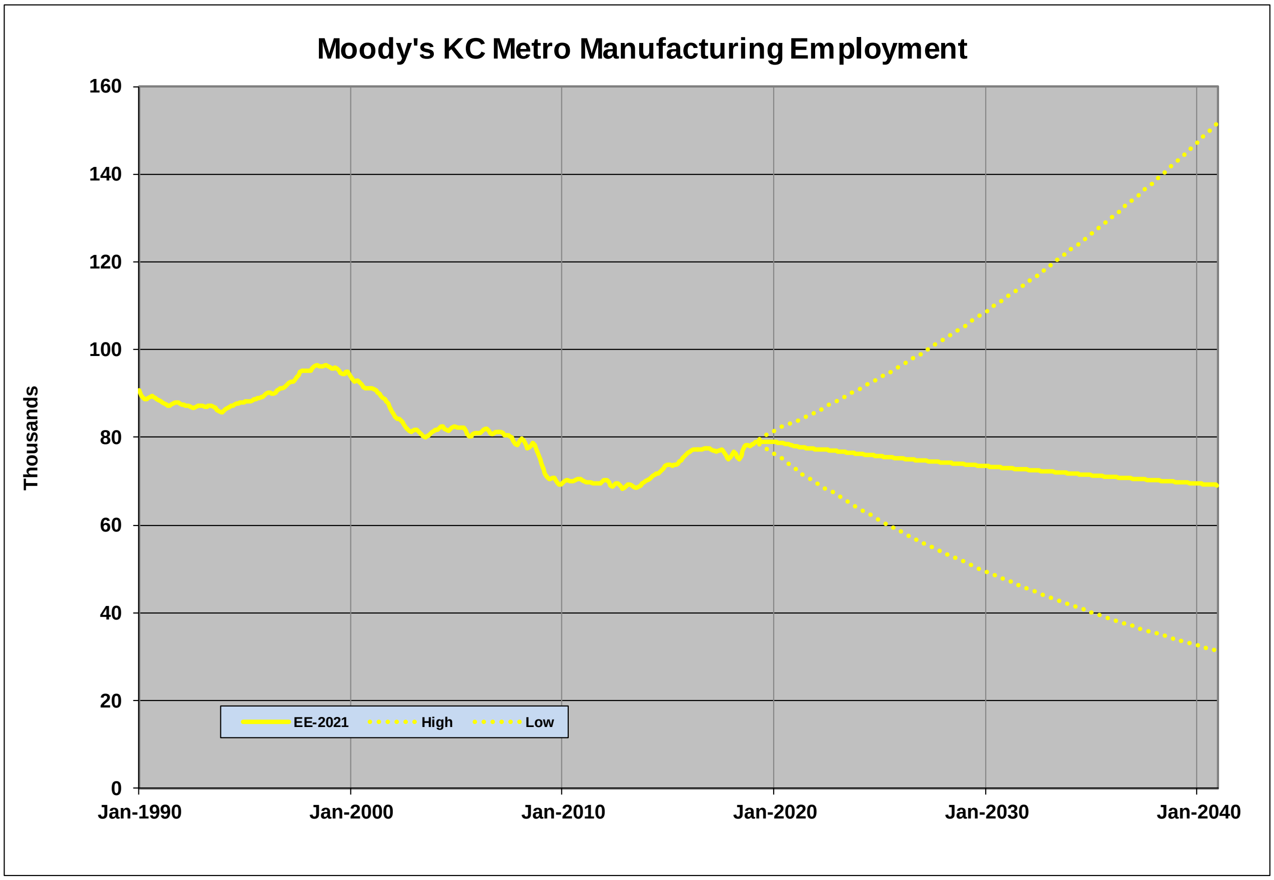
The household data and projection shows robust growth from 1990 until the beginning of the last recession at the end of 2007, at which time growth slowed substantially. Housing stock has expanded since 2012 and the growth is expected to continue at a slowly decelerating pace until 2030 when the pace begins to decelerate more rapidly.

Figure 45: KC Metro Employment Non-Manufacturing



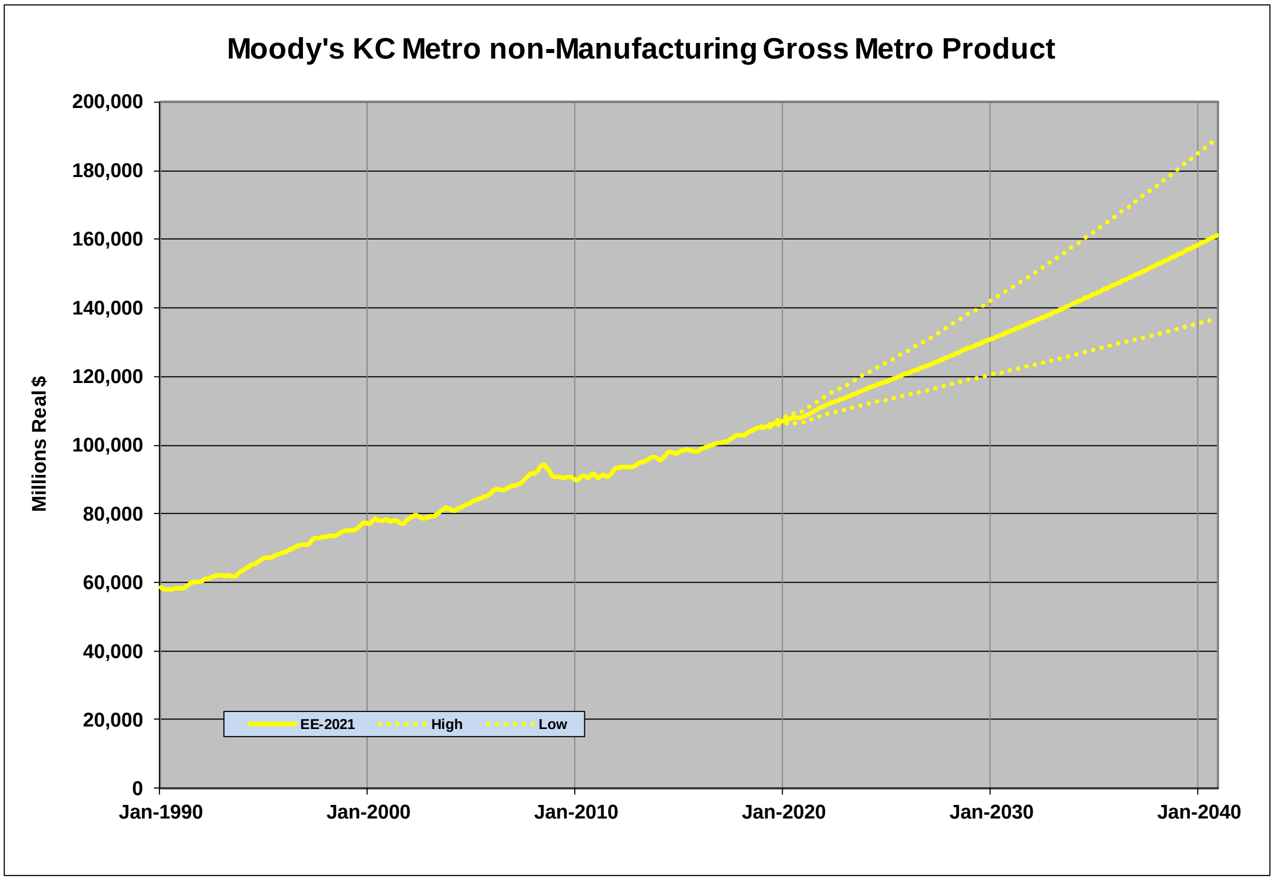
Non-manufacturing employment showed very strong growth in the 1990s, 1.9% per year, then stalled after the 2001 recession, picked up strongly in 2004 and then turned negative during the last recession. Growth returned in 2012 and grew stronger starting in 2015. Moody's expects continued growth though at a slower pace, following the brief pause in 2020 due to the COVID-19 pandemic.

Figure 46: KC Metro Employment Manufacturing



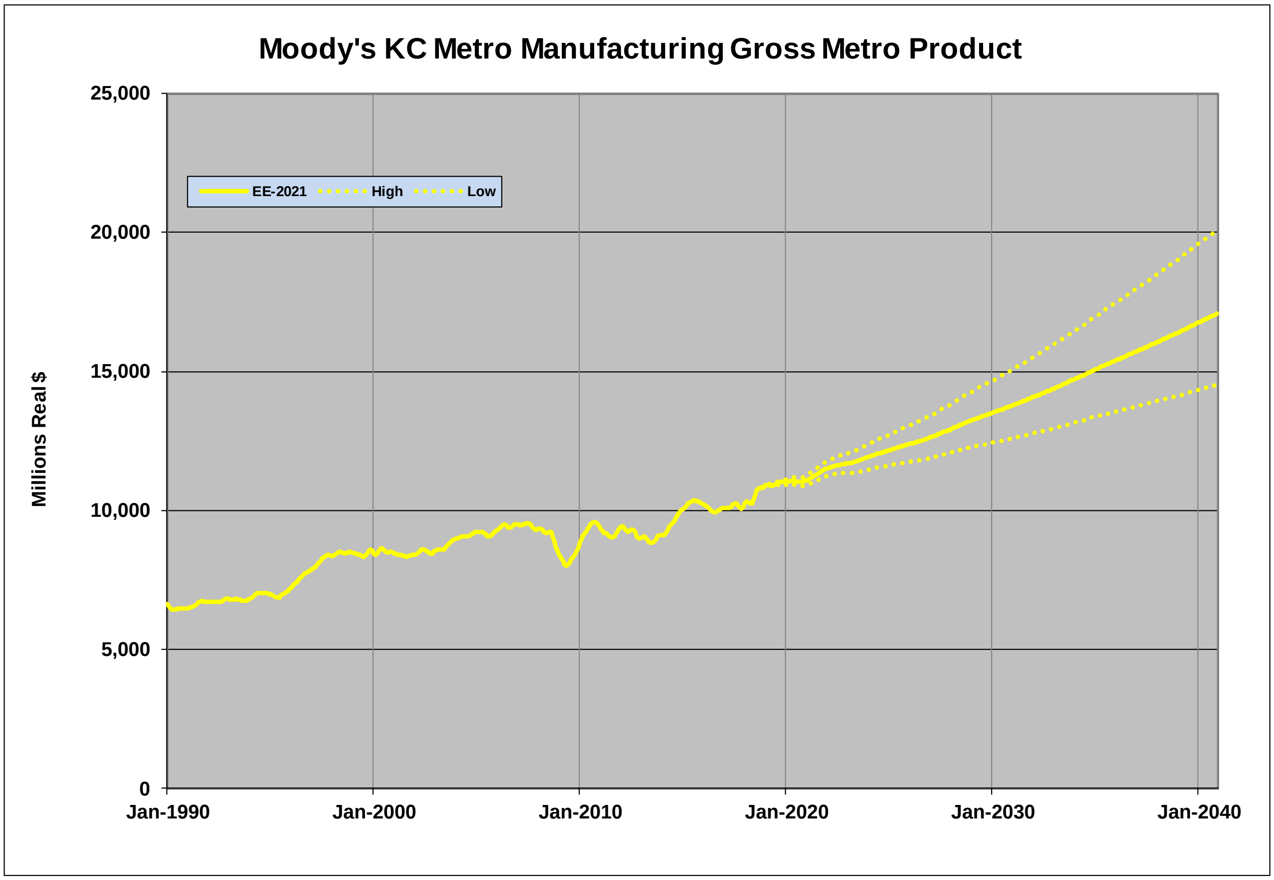
Manufacturing employment peaked in the late 1990s and has fallen since. It fell precipitously between 1999 and 2003 and again during the last recession. After regaining some of the jobs lost in the aftermath of the last recession, Moody's expects employment to resume its historical decline.

Figure 47: KC Metro Gross Metro Product Non-Manufacturing



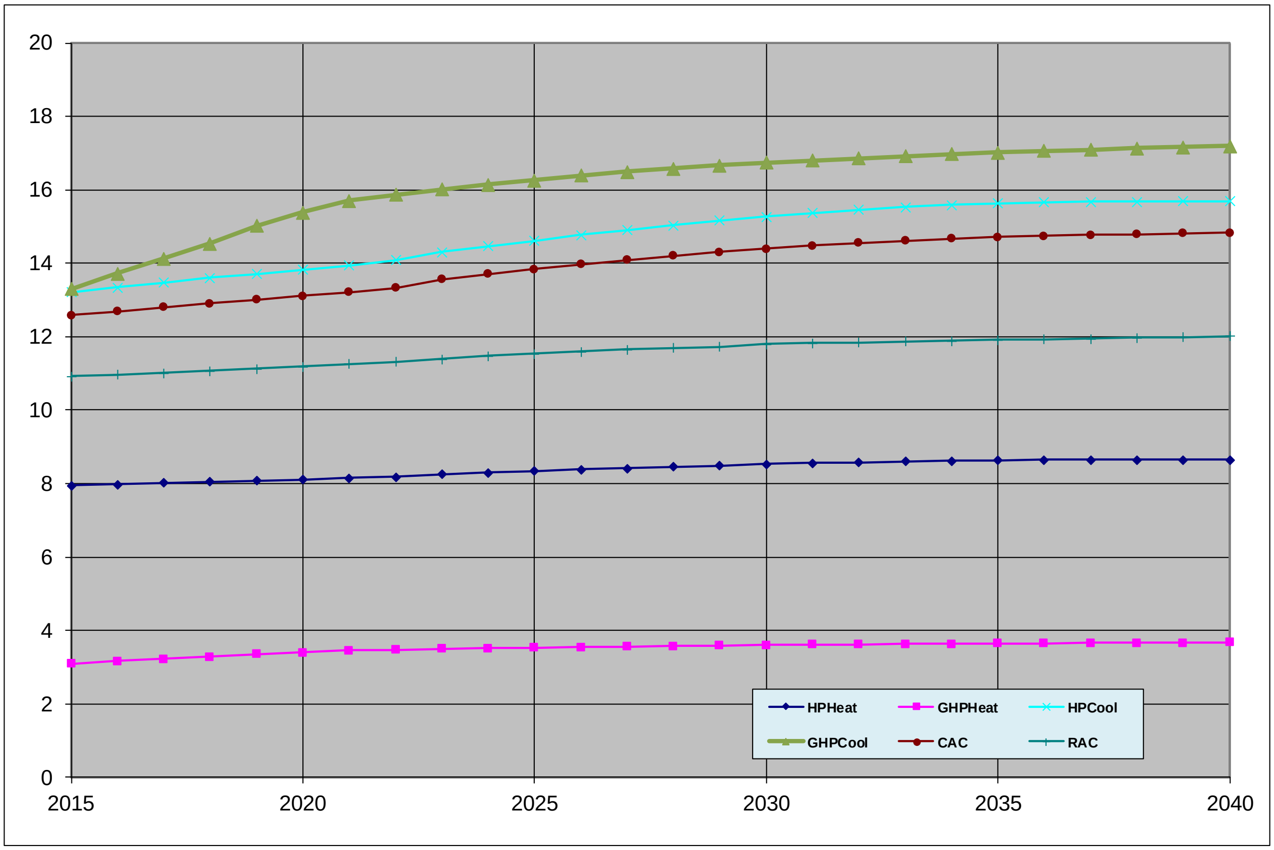
Real non-manufacturing gross metro product grew 3% per year during the 1990s, slowed down a bit after that and then declined during the last recession. GMP is growing faster than employment because of increasing productivity, a trend seen nationally and across many service sectors. Moody's expects strong growth over the next two decades.

Figure 48: Gross Metro Product Manufacturing



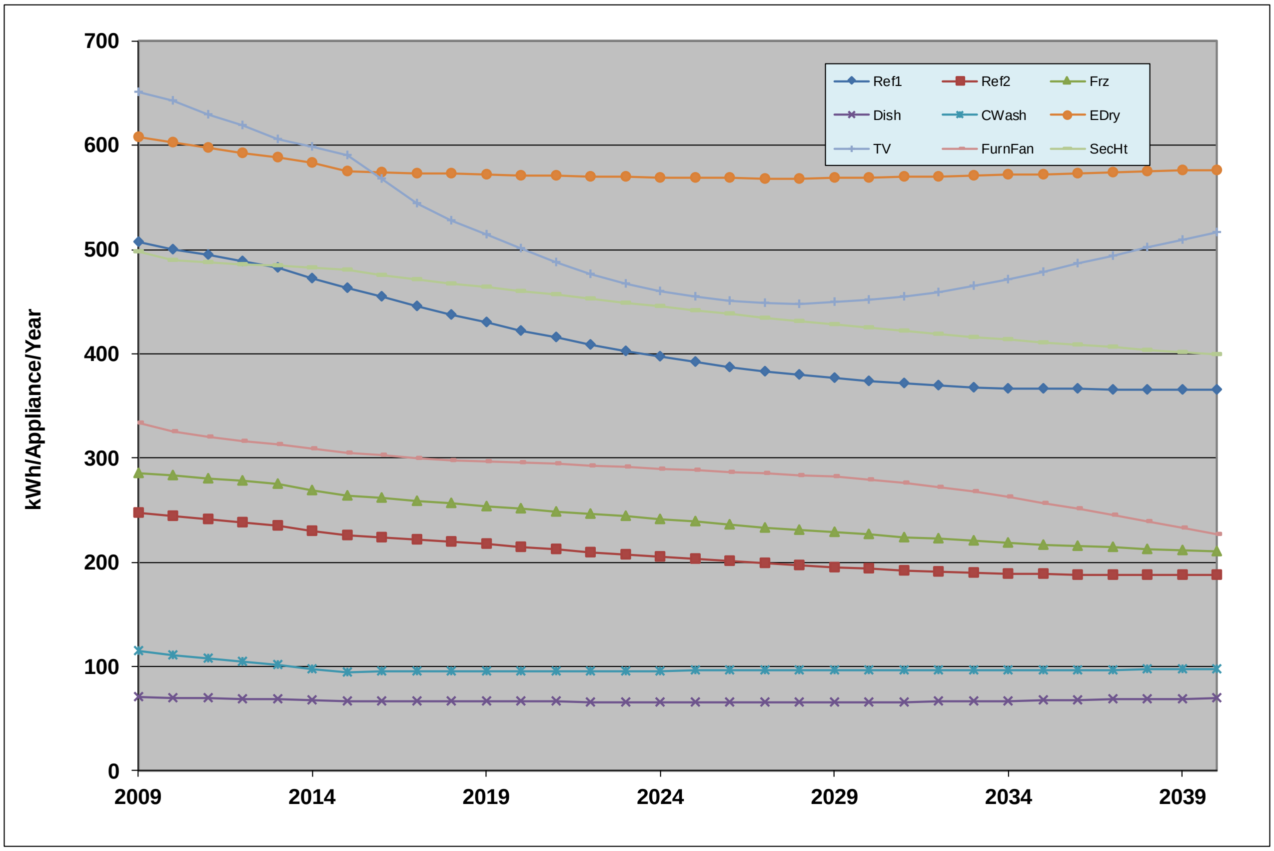
Real gross metro product from the manufacturing sector grew strongly during the 1990s and then fell flat until it plunged during the last recession. Growth has been somewhat volatile since 2008, but positive in total. Moody's expects growth in line with the recent historical trend. GMP for this sector is growing while employment is flat or declining because of increasing productivity, automation of the manufacturing processes and because many of the labor-intensive portions of production have moved overseas where labor cost is lower.

Figure 49: DOE Stock Average Appliance Efficiency Projections



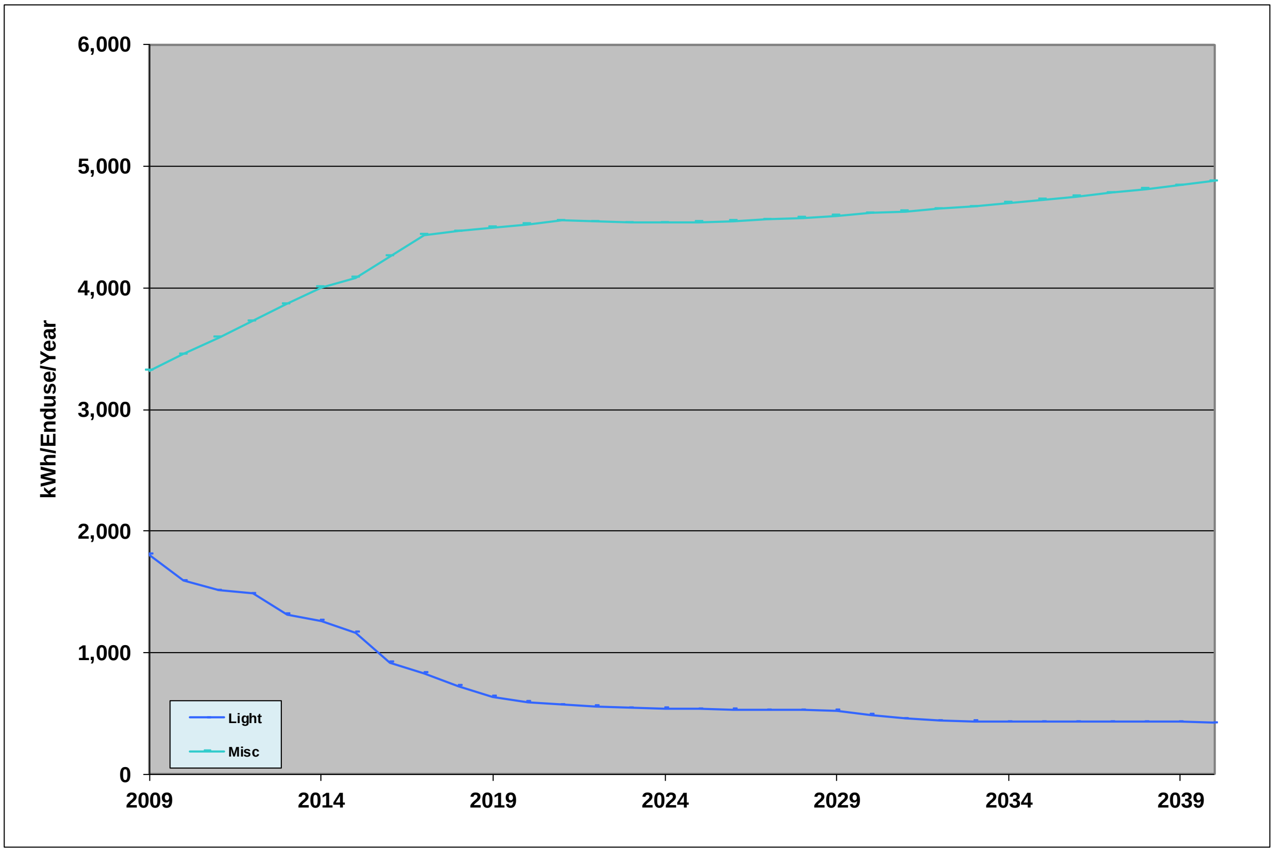
DOE is expecting increases in the stock average appliance efficiencies for residential heating and cooling equipment, resulting from appliance standards. The standards impact the stock average efficiency both due to new construction and replacement units.

Figure 50: DOE UEC Projections (<1000 kWh/year)



The decline in UEC for refrigerators and freezers is expected to continue for another decade before beginning to level. TV UEC has fallen sharply in recent years but is expected to flatten by the late 20s and growth thereafter. Furnace fans are expected to continue to see a decline in UEC. Dishwashers and electric dryers are expected to see flat UEC due to slightly increasing saturation levels offsetting efficiency gains.

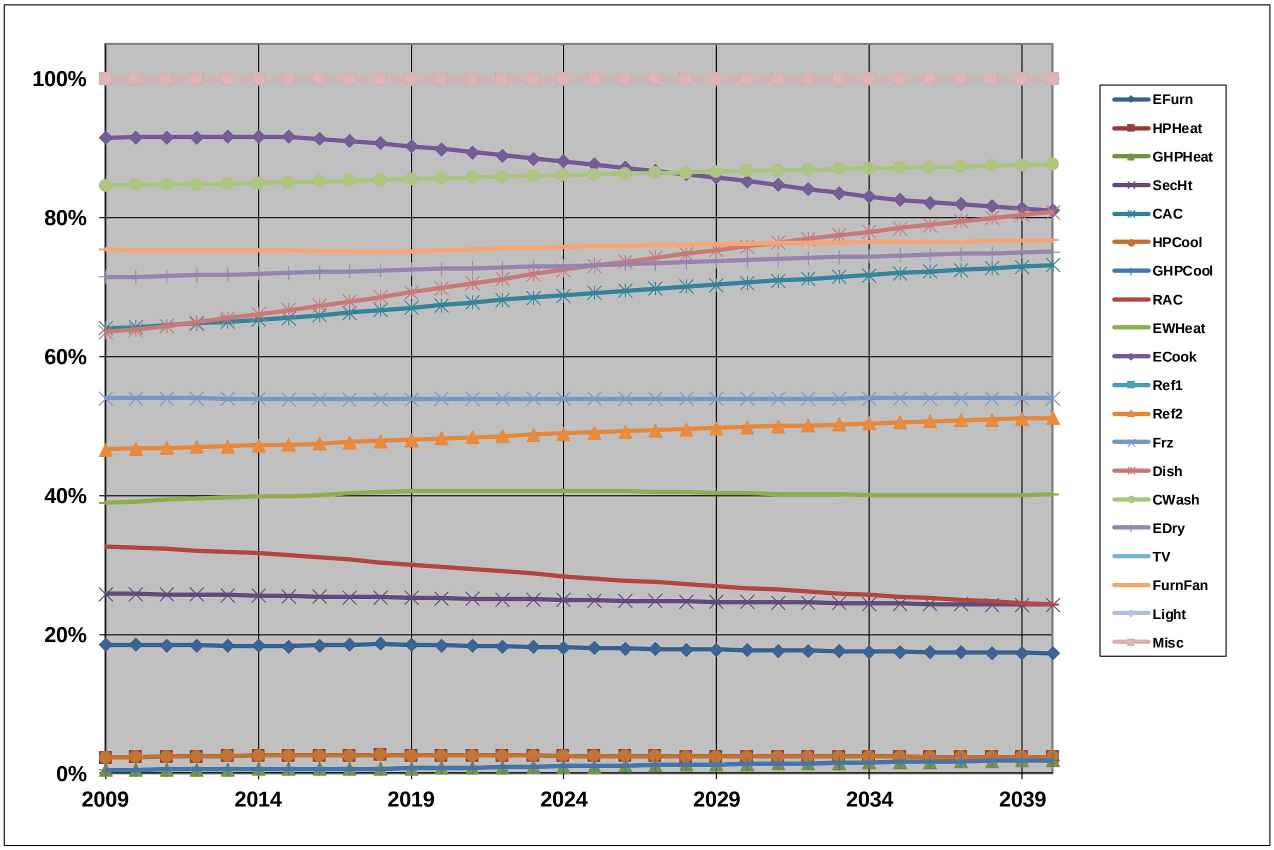
Figure 51: DOE UEC Projections (>1000 kWh/year)



The UEC for lighting is expected to continue declining due to increased saturation of CFL and LED light bulbs. Lighting standards, many of which began in 2007 through 2015, will continue to impact consumption as less efficient incandescent and fluorescent lights are replaced with LED and result in further declines in UEC.

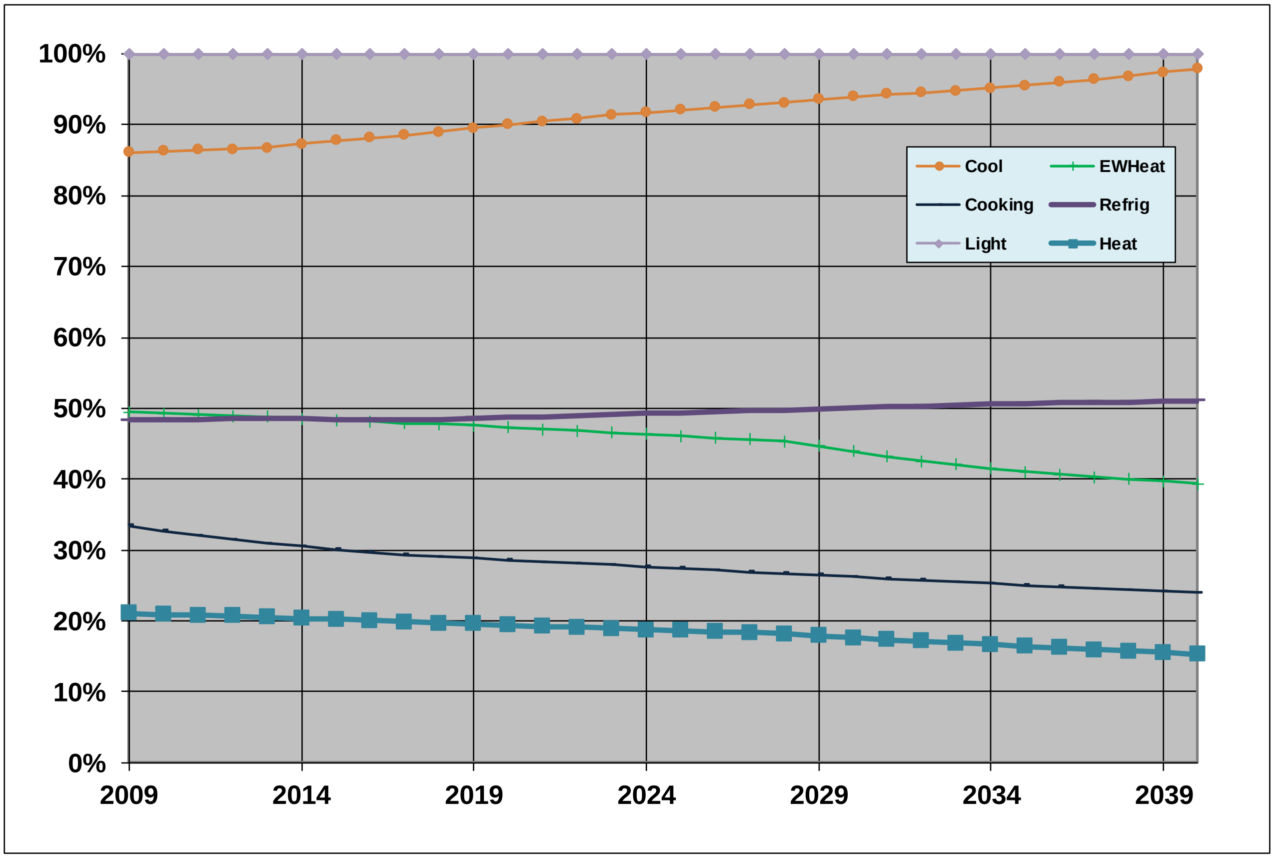
Miscellaneous UEC grew rapidly in the late 1990s and early 2000s before decelerating (from 5% to 3%) in 2006 and then again decelerating in 2016. The EIA expects miscellaneous UEC to grow slowly at less than 1% per year going forward.

Figure 52: DOE Electric Appliance Saturation Projections (< 100%)



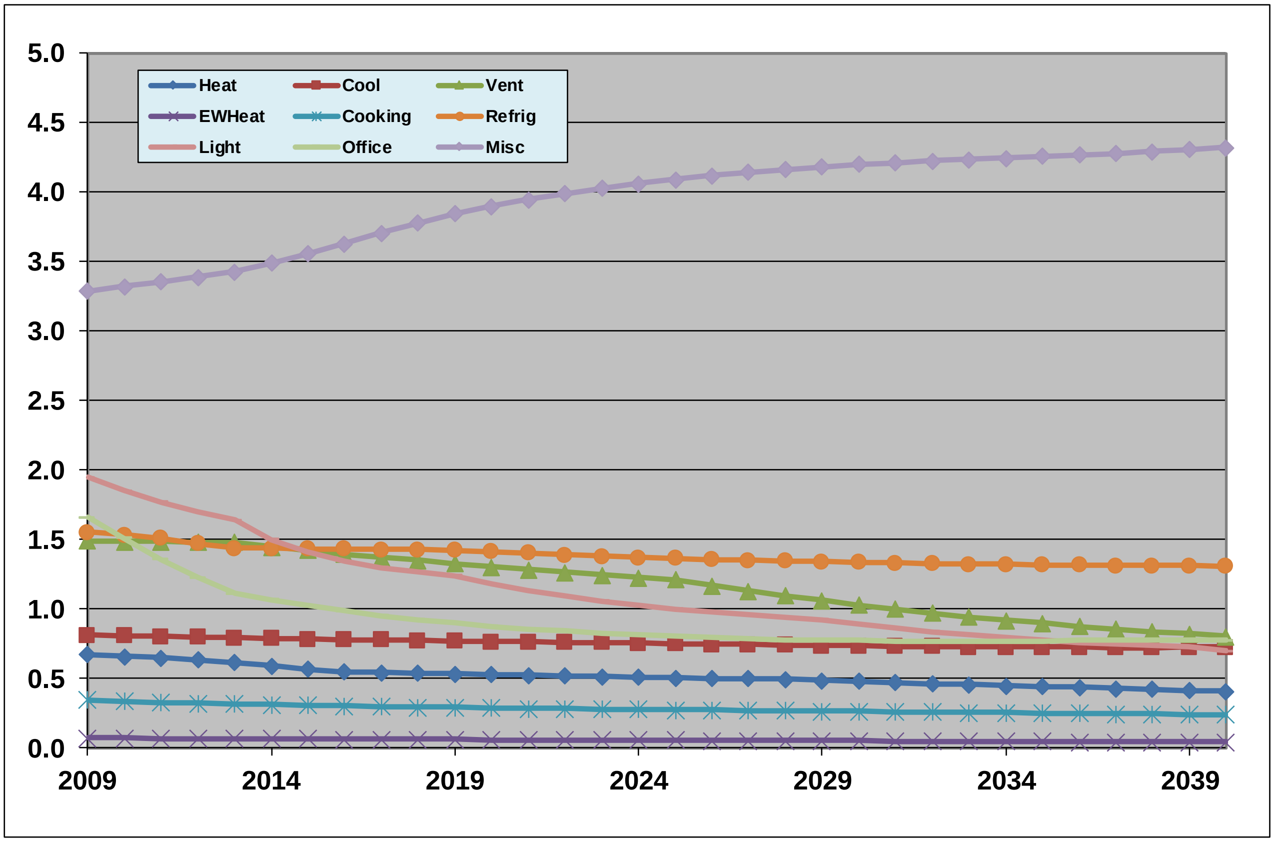
DOE saturation projections shown above are in line with recent historical trends.

Figure 53: DOE Commercial Equipment Saturation Projections (Average over all Commercial Building Types)



DOE commercial sector saturations are mostly in line with trends in recent historical data. Electric water heat saturation is projected to experience a sharper decline starting near the late 20s, departing from its recent gradual decline.

Figure 54: DOE Commercial EUI Projections (Average over all Commercial Building Types)



DOE estimates of the EUI for lighting has been declining since 1995 and started falling more rapidly in 2012, due to the use of CFLs and LEDs, especially for lodging and in recessed fixtures in offices. New refrigeration standards will become effective in 2017.[vii] The heating EUI is declining and expected to further decline. A new standard for commercial heating and cooling equipment became effective in 2017.[viii] The EUI for miscellaneous equipment has been rising rapidly and is expected to continue that trend, though it is lower than previous outlooks due to the incorporation of the 2012 CBECS. One of the prominent end-uses in the miscellaneous equipment category is medical equipment. Expansion in the health care sector and expanded use of medical equipment explain part of the intensity growth for miscellaneous equipment.

7.2.4 SPECIFICATION AND QUANTIFICATION OF FACTORS

4. Where judgment has been applied to modify the results of a statistical or mathematical model, the utility shall specify the factors which caused the modification and shall explain how those factors were quantified.

Evergy Metro used the forecasts of economic and demographic variables as is from Moody's Analytics.

The projections of appliance saturations from DOE were calibrated to the results of our Residential appliance saturation survey and Commercial & Industrial equipment saturation survey. An additional calibration was made to lighting to account for the Evergy Metro lighting program that had been in place prior to the implementation of the 2013 federal lighting standard. The adjustment shows a stronger increase in lighting efficiency in the historical period and a slower rate of increase in efficiency in the forecast period.

7.3 NET SYSTEM LOAD FORECAST

(C) Net System Load Forecast. The utility shall produce a forecast of net system load profiles for each year of the planning horizon. The net system load forecast shall be consistent with the utility's forecasts of monthly energy and peak demands at time of summer and winter system peaks for each major class.

Evergy Metro has produced an hourly forecast for each major class and the sum of these forecasts is the hourly forecast of NSI.

SECTION 8: LOAD FORECAST SENSITIVITY ANALYSIS

(8) Load Forecast Sensitivity Analysis.

The utility shall describe and document its analysis of the sensitivity of the dependent variables of the base-case forecast for each major class to variations in the independent variables identified in subsection 4 CSR 240-22.030(8).

To perform a sensitivity analysis, we are using a method that was suggested by the Missouri Public Service Commission Staff for Evergy Metro's IRP. For each customer class, MWh sales were regressed on important driver variables and degree days and the standardized variables are used to show the relative importance of each explanatory variable. We also show the elasticity for each driver variable as measured by the statistical regression. The sensitivity analysis was run using the revenue class groups as opposed to the class cost of service groups in order to use a longer historical data set. Class cost of service historical data is available back to mid-2005. The analysis was repeated using revenue classes, residential, commercial and industrial with monthly data available from 2001 to 2020.

Table 37 displays the results for MO residential customers. Among the driving variables, the cooling degree days' variable has the largest standardized coefficient, followed by the heating degree days variable. Note that the base temperature for the cooling degree days' variable was 65^0 F and the base temperature for the heating degree days variable was 55^0 F. The variable hddPriceRatio variable is heating degree days with a base temperature of 55^0 F times the price of natural gas for the West North Central Region. The purpose of this variable is to measure the impact of gas and electric prices on electric space heating loads. The trends in both heating degree day response and cooling degree day response are significant as well. The variable BDays is the number of billing days averaged over each billing cycle. The estimation periods used for these regressions are monthly from January 2001 to June 2020 or January 2002 to June 2020.

Table 37: Missouri Metro Residential

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
BDays	5,113,290	9.2	0.76
Population	1,765,313	1.3	0.18
hddPriceRatio	11,734,683	3.7	0.04
resCusCDD65	65,947,819	79.2	0.24
resCusHdd55	32,096,018	10.3	0.13
HDDtrend	8,218,874	5.2	0.00
CDDtrend	-4,690,064	-5.2	0.00
calib	-1,610,809	-2.4	-0.35
COVID	687,359	1.0	0.00

Table 38 provides the results for Missouri commercial customers. The variable with the largest standardized coefficient is cooling degree days. The heating degree day base temperature for the commercial model was the same as the residential model, but the cooling degree day base temperature was 60^0 F. Heating degree days, trend in heating degree days and the HDDpriceRatio variable all had similar impact for commercial customers. Several economic drivers were tested and were significant, including Non-Manufacturing Gross Metro Product and Households.

Table 38: Missouri Metro Commercial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
GP_Non_Man	10,025,027	7.8	0.30
BDays	9,204,249	28.1	0.81
HDDpriceRatio	13,756,651	4.0	0.03
comCusCDD60	40,525,249	39.3	0.10
comCusHdd55	8,019,685	2.4	0.02
Jun02	-1,377,641	-2.5	0.00
Apr03	-1,462,793	-2.7	0.00
HddTrend	9,993,909	6.0	0.00
EffTrend	-10,592,160	-8.5	-0.26
COVID	-4,022,442	-5.3	0.00

The Missouri industrial model results are shown in Table 39. The cooling degree variable has the largest standardized coefficient, followed by manufacturing employment of the economic variables and industrial customers.

Table 39: Missouri Metro Industrial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
Emp_Man	4,173,149	7.8	0.62
indCus	4,030,327	5.6	0.44
prElecCus	-1,448,283	-4.0	-0.11
indCusCDD60	5,563,239	10.3	0.05
Aug05	-1,536,662	-5.0	0.00
Jul19	-1,485,453	-4.7	0.00
Apr20	-911,629	-2.7	0.00

Table 40 shows the results for residential customers in Kansas. The variables with the largest standardized coefficients are degree days followed by the hddPriceRatio. The hddPriceRatio variable is the same formula used for the same named variables in the Missouri models.

Table 40: Kansas Metro Residential

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
BDays	8,232,349	12.4	1.13
Population	5,209,709	3.1	0.48
hddPriceRatio	15,019,442	3.5	0.05
resCusCDD65	74,910,462	35.9	0.25
resCusHdd55	13,943,633	2.0	0.05
CDDtrend	-4,413,423	-2.1	-0.01
HDDtrend	12,155,100	3.3	0.04
Jun18	2,571,833	4.6	0.00
Aug18	-2,192,072	-3.9	0.00
COVID	3,146,651	3.6	0.00
calib	-4,813,786	-6.0	-0.99

Table 41 shows the results for commercial customers in Kansas. The degree day variables represented the variables with the largest coefficients, with the heating trend saturation supporting heating degree day overall impact.

Table 41: Kansas Metro Commercial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
GP_Non_Man	9,988,482	7.2	0.50
BDays	4,620,416	14.2	0.56
HDDpriceRatio	5,499,419	1.6	0.02
comCusCDD60	29,213,148	41.8	0.10
comCusHdd55	1,648,713	0.3	0.01
HDDtrend	9,441,269	3.3	0.03
BaseEffTrend	-4,504,459	-3.3	-0.20
Oct08	904,722	2.5	0.00
Sep18	-1,843,585	-5.2	0.00
COVID	-3,265,215	-5.3	0.00

Table 42 reports the results of the sensitivity analysis for manufacturing customers in Kansas. The largest coefficients are from Industrial customers CDD60 and Manufacturing Employment variables.

Table 42: Kansas Metro Industrial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
Emp_Man	1,705,845	6.0	0.72
indCus	728,895	3.6	0.38
prElec	-533,586	-4.6	-0.17
indCusCDD60	2,341,933	19.9	0.07
Sep00	-139,633	-2.9	0.00
Dec00	162,640	3.4	0.00

8.1 TWO ADDITIONAL NORMAL WEATHER LOAD FORECASTS

(A) The utility shall produce at least two (2) additional normal weather load forecasts (a high-growth case and a low-growth case) that bracket the base-case load forecast. Subjective probabilities shall be assigned to each of the load forecast cases. These forecasts and associated subjective probabilities shall be used as inputs to the risk analysis required by 4 CSR 240-22.060.

Evergy Metro used two additional economic forecasts from Moody's Analytics to produce high-growth and low-growth load forecast scenarios. These additional scenarios represent economic growth of two standard deviations above and below the base case forecast.

In addition to these two scenarios, Evergy Metro produced an additional scenario representing significant loss of customer.

Evergy Metro constructed this scenario by subtracting the energy and peak demand from the largest customer in both Kansas and Missouri from the results for the base case scenario. The most recent 12 billing records from each customer were used and the energy and peak from each month was used for that particular month in the forecast. Losses were added to the energy and peak demands.

The corresponding figures below show the base-case, low-case, high-case, and significant loss forecasts for energy and demand. The impact of the last recession and the economic malaise since then are evident in the plot for energy. Growth in the forecast is lower than it was prior to the last recession and this is primarily because U.S. growth prior to the recession was fueled by circumstances that will not be repeated in the forecast horizon such as extremely lax lending standards.

Figure 55: MO Metro Base, Low, High, Significant Loss and Electrification Net System Input Forecast

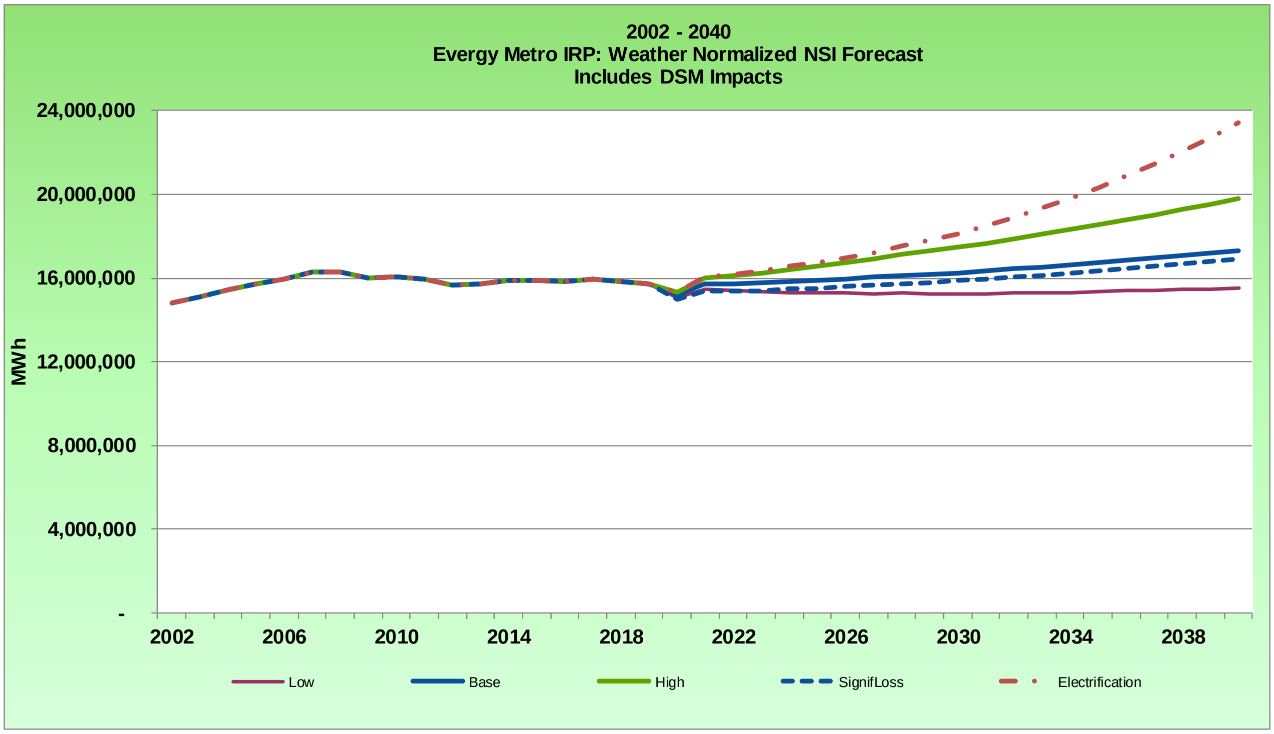
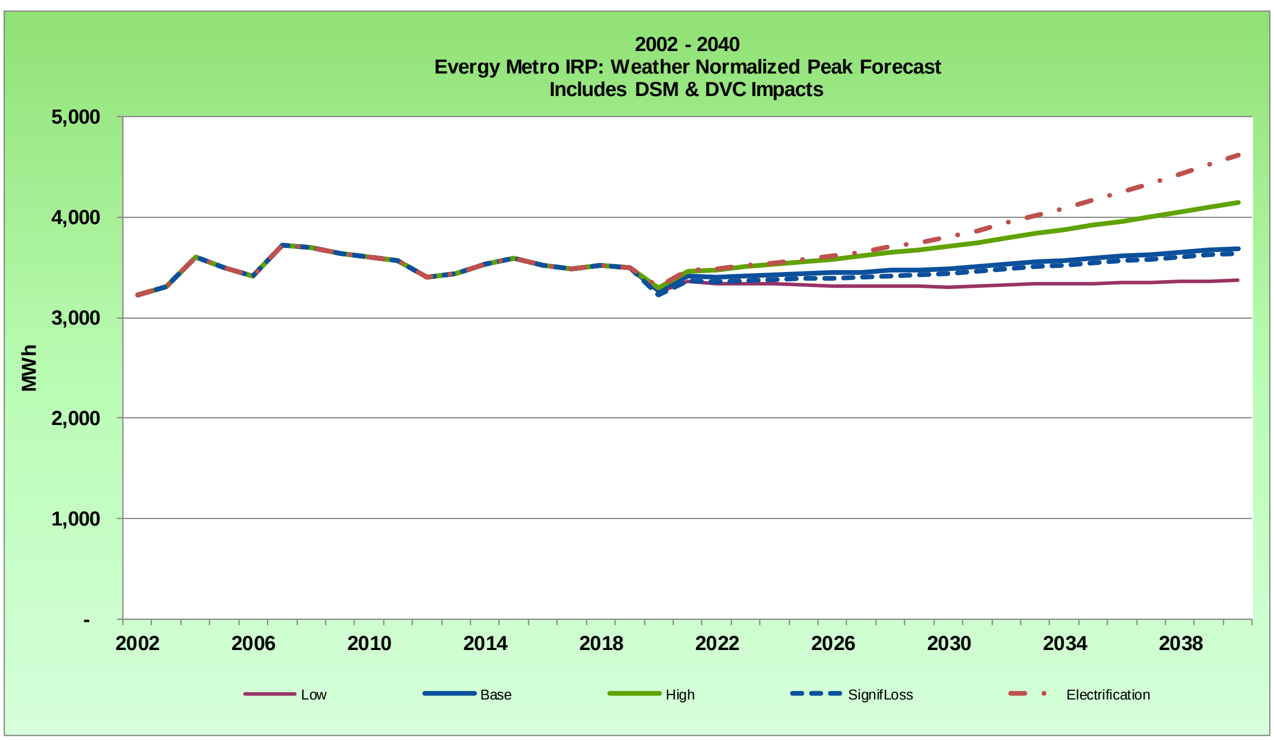


Figure 56: MO Metro Base, Low, High, Significant Loss and Electrification Peak Demand Forecast



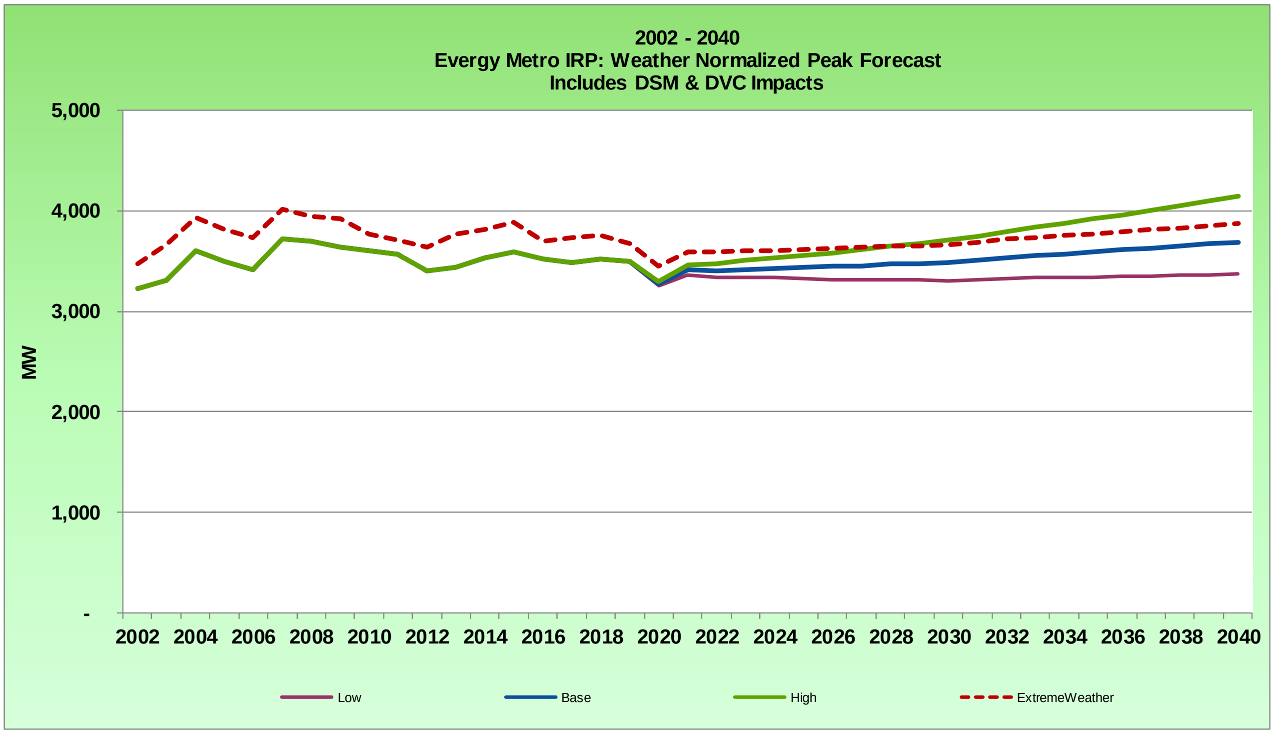
8.2 ESTIMATE OF SENSITIVITY OF SYSTEM PEAK LOAD FORECASTS TO EXTREME-WEATHER

(B) The utility shall estimate the sensitivity of system peak load forecasts to extreme weather conditions. This information shall be considered by utility decision-makers to assess the ability of alternative resource plans to serve load under extreme weather conditions when selecting the preferred resource plan pursuant to 4 CSR 240-22.070(1).

Evergy Metro created a forecast scenario using the base case economic scenario and weather from the 4 warmest years in terms of cooling degree days at KCI. These years were 1980, 1988, 2006 and 2012. The number of cooling degree days those years were 1,746, 1,724, 1,724 and 1,839. The scenario was created by running our computer programs with normal weather computed with those four years instead of with 30 years. In 2021, the peak net of DSM and DVC rose from 3,418 mW in the base case scenario to 3,599 mW in the extreme weather scenario. In 2022, the peak net of DSM and DVC increased from 3,436 (base case) to 3,616 extreme weather scenario. The complete set of results is in a file, *Metro NSI_Peak Monthly_Annual.xls.* This file contains monthly NSI and peak load for all forecast scenarios.

The corresponding figures below show the base-case, low-case, high-case, and extreme weather forecasts for energy and demand.

Figure 57: MO Metro Base, Low, High, and Extreme Weather Peak Demand Forecast



8.3 ENERGY USAGE AND PEAK DEMAND PLOTS

(C) The utility shall provide plots of energy usage and peak demand covering the historical database period and the forecast period of at least twenty (20) years.

1. The energy plots shall include the summer, non-summer, and total energy usage for each calendar year. The peak demand plots shall include the summer and winter peak demands.

The figures below represent actual and weather normalized Net System Input (Energy) for summer, non-summer, and total year for the base case forecast. Corresponding tables can be found in *Appendix 3D* and in the file *IRP_8C_EvergyMetro_NSI_Peak.xls*. Weather normalization significantly smooths out the energy plots.

Figure 58: MO Metro Base Case Actual and Weather Normalized Summer Energy Plots

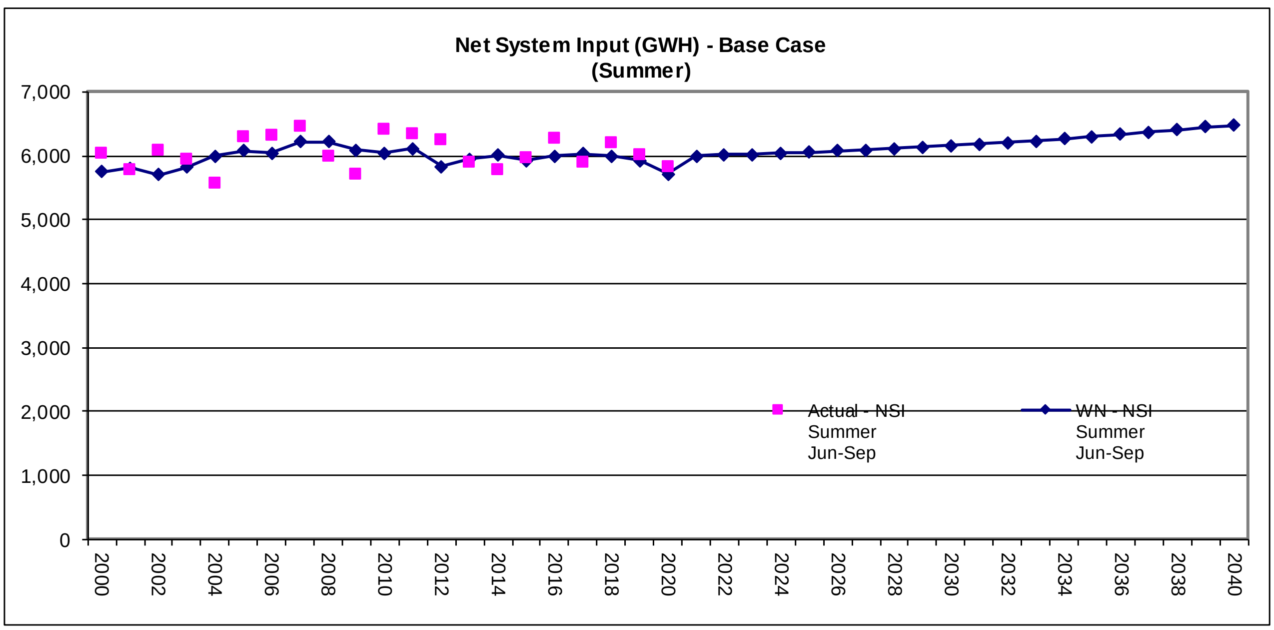


Figure 59: MO Metro Base Case Actual and Weather Normalized Non-Summer Energy Plots

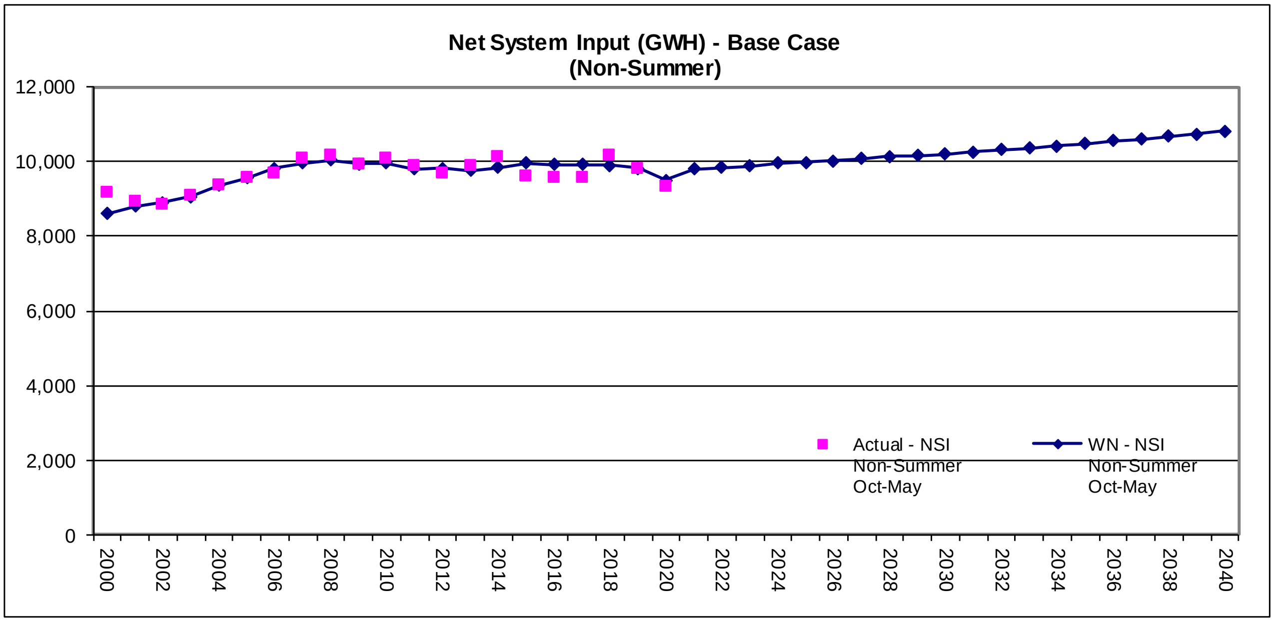
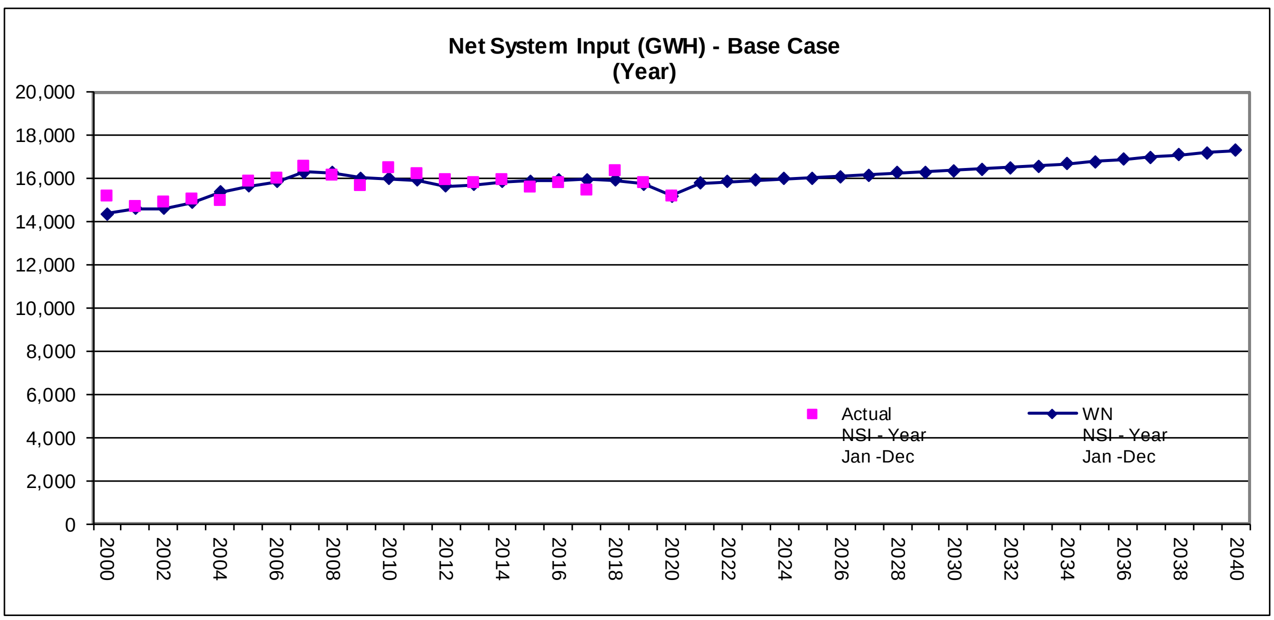


Figure 60: MO Metro Base Case Actual and Weather Normalized Total Energy Plots



The figures below represent actual and weather normalized peak demand for summer and non-summer for the base case forecast. Annual peak demand plots are not shown, since they are the same as summer demand plots. Corresponding tables can be found in *Appendix 3D* and the file *IRP_8C_EvergyMetro_NSI_Peak.xls*.

Figure 61: MO Metro Base Case Actual and Weather Normalized Summer Peak Demand Plots

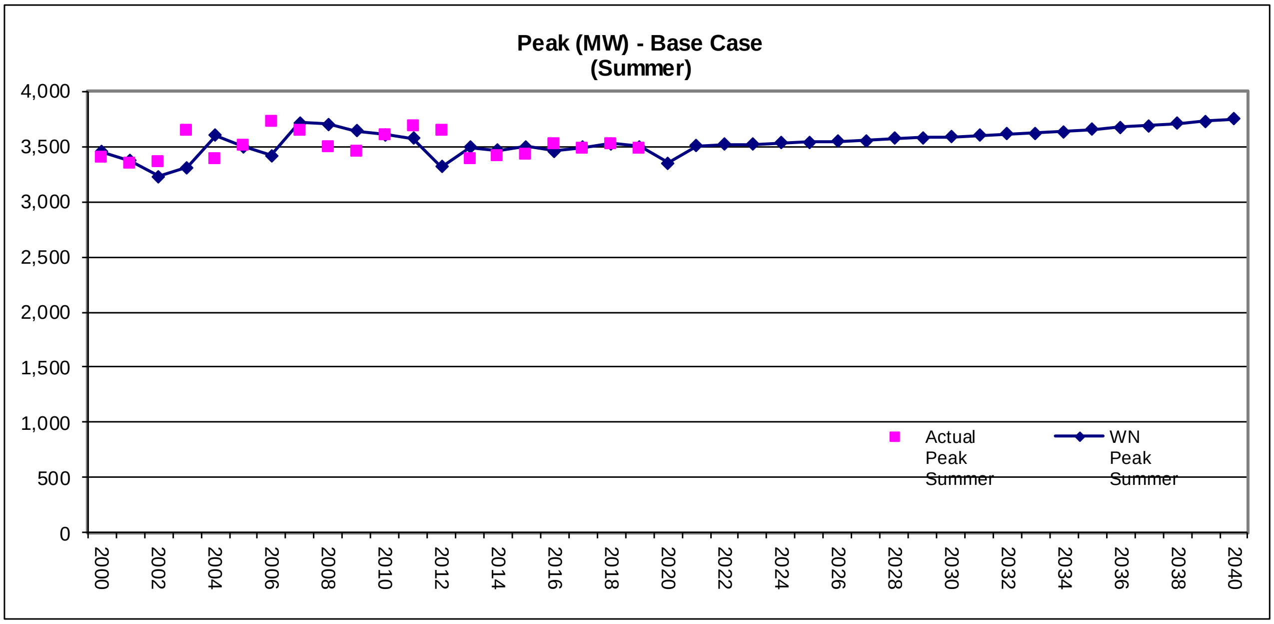
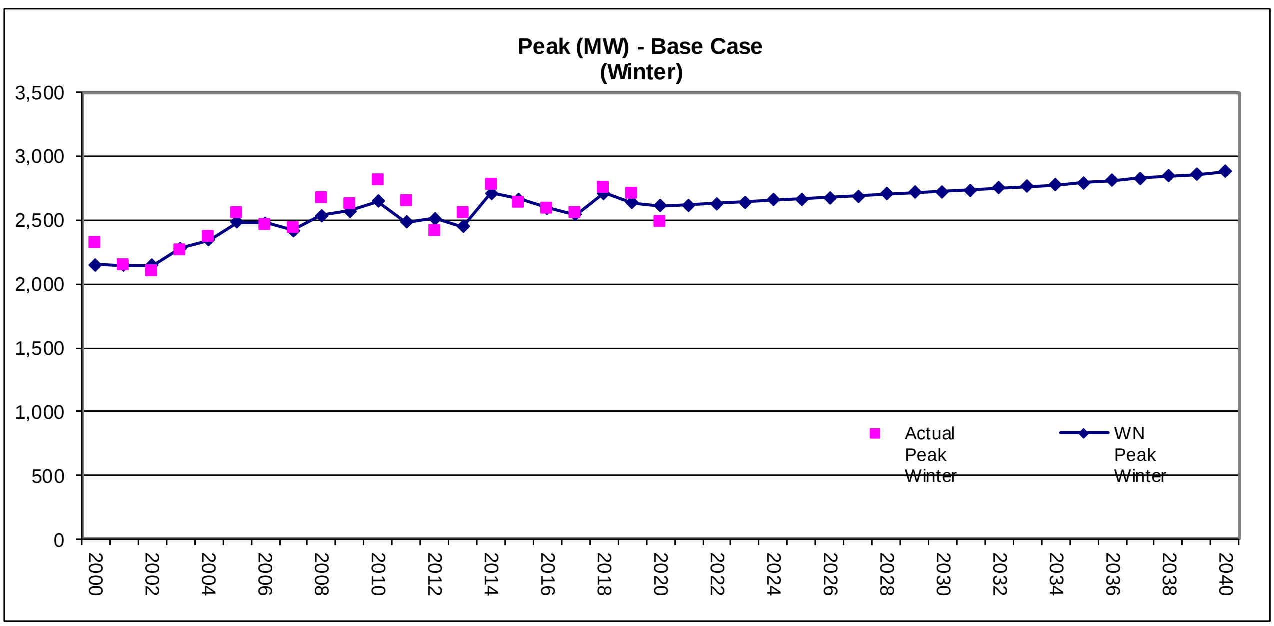


Figure 62: MO Metro Base Case Actual and Weather Normalized Winter Peak Demand Plots



2. The historical period shall include both actual and weather-normalized values. The forecast period shall include the base-case, low-case, and high-case forecasts.

The figures below represent Net System Input (energy) for summer, non-summer, and the whole year for the base, low and high scenario forecasts. Corresponding tables can be found in *Appendix 3D* and the file *IRP_8C_EvergyMetro_NSI_Peak.xls*.

Figure 63: MO Metro Base-Case, Low-Case, and High-Case Summer Energy Plots

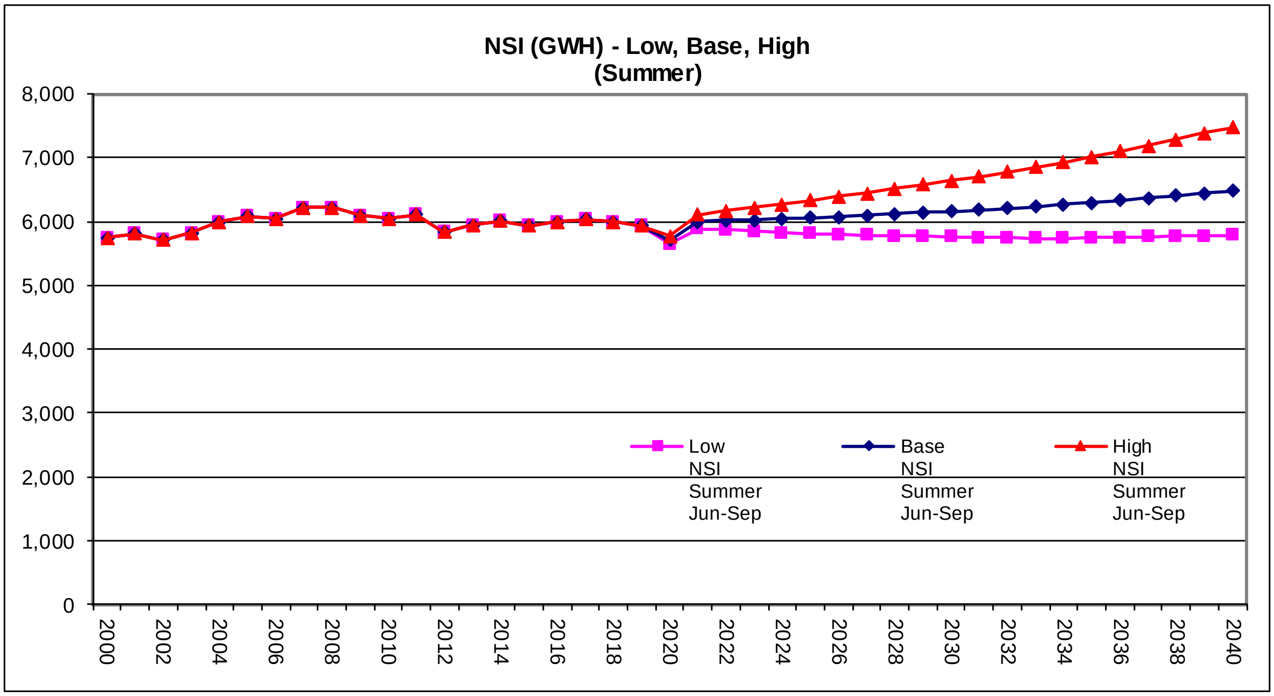


Figure 64: MO Metro Base-Case, Low-Case, and High-Case Non-Summer Energy Plots

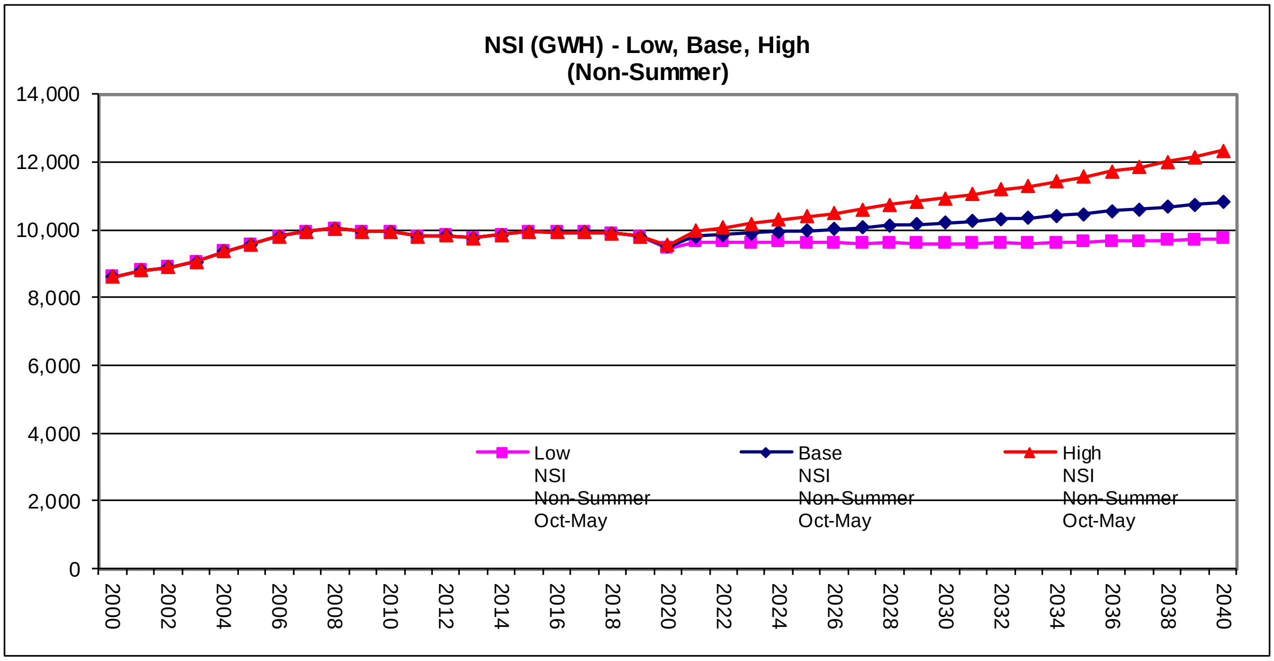
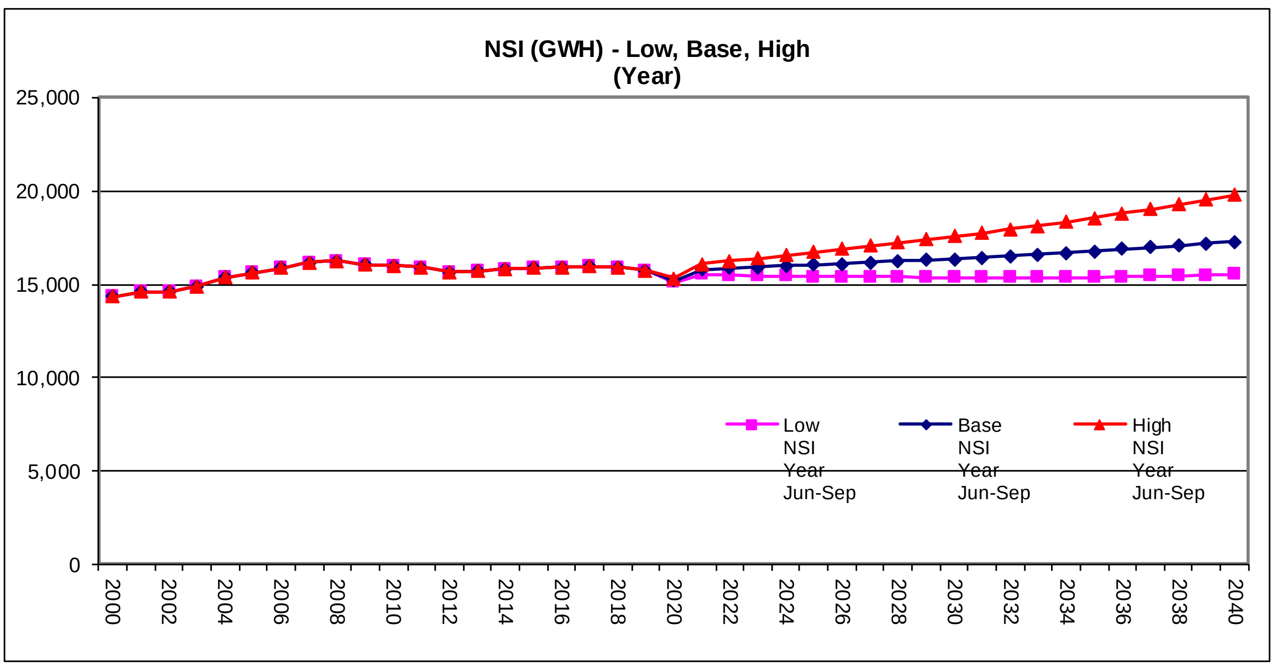


Figure 65: MO Metro Base-Case, Low-Case, and High-Case Total Energy Plots



The figures below represent peak demand for summer and non-summer for the base, low, and high scenario forecasts. Annual peak demand plots are not shown, since they are the same as summer demand plots. Corresponding tables can be found in *Appendix 3D* and in the file *IRP_8C_EvergyMetro_NSI_Peak.xls*.

Figure 66: MO Metro Base-Case, Low-Case, and High-Case Summer Peak Demand Plots

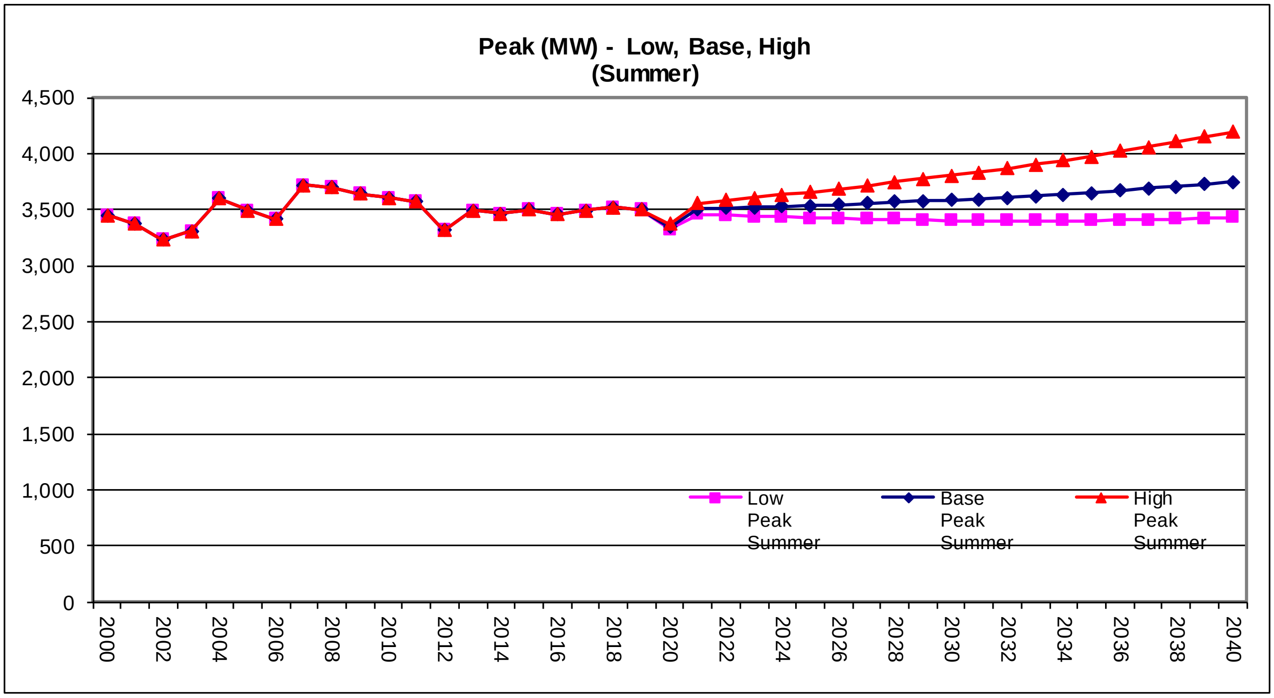
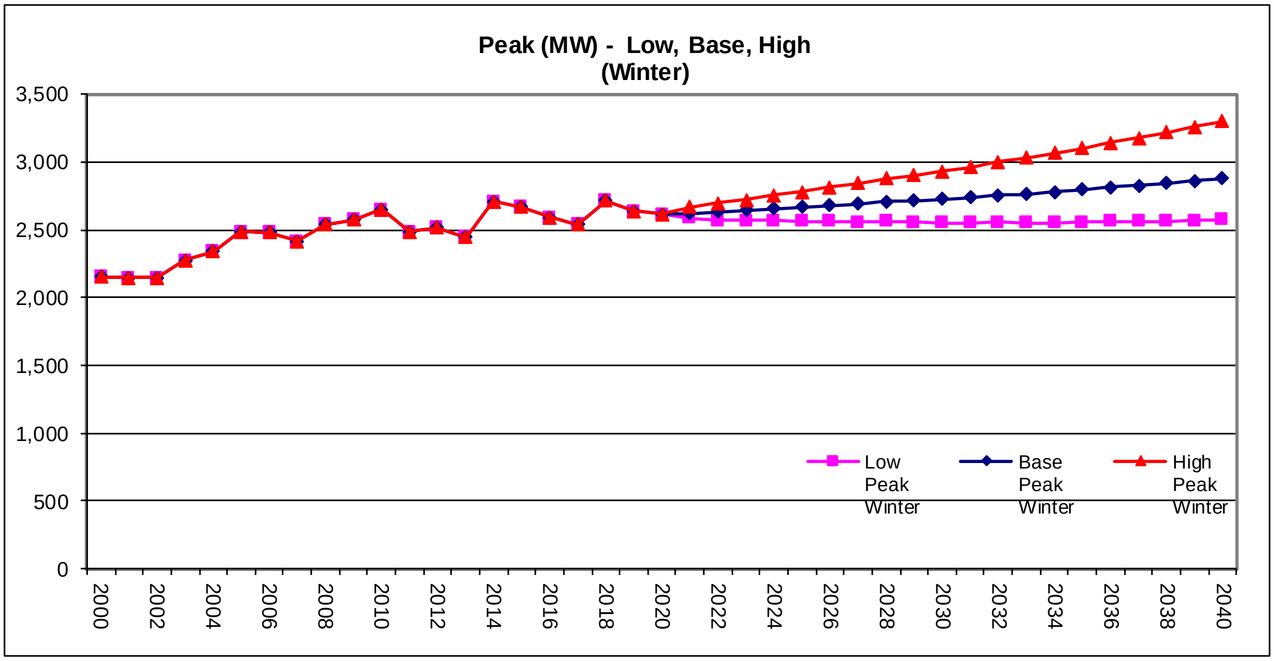


Figure 67: MO Metro Base-Case, Low-Case, and High-Case Winter Peak Demand Plots



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i http://www1.eere.energy.gov/buildings/appliance_standards/residential/residential_cac_hp.html
ii Appliance and Equipment Standards Program, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. https://appliance-standards.org/products-and-links.
iii Appliance and Equipment Standards Program, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. https://appliance-standards.org/products-and-links.
iv Appliance and Equipment Standards Program, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. https://appliance-standards.org/products-and-links.
v http://www.eia.gov/analysis/model-documentation.cfm
vi See regulatory_programs_mypp.pdf .
vii www1.eere.energy.gov/buildings/appliance_standards/commercial/refrig_equip_final_rule.html and www1.eere.energy.gov/buildings/appliance_standards/commercial/automatic_ice_making_equipment.html
viii https://www.regulations.gov/document?D=EERE-2014-BT-STD-0048-0102