Evergy Metro

Volume 3

Load Analysis and Load Forecasting

Integrated Resource Plan

20 CSR 4240-22.030

April 2024

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Volume 3 – Load Analysis and Load Forecasting

Highlights

- Evergy Metro expects energy consumption to grow 0.6% and peak demand to grow 0.4% annually from 2023-2043.
- Residential energy consumption is expected to provide the most growth over the next 20 years.
- Evergy Metro customers are expected to grow 0.1% annually from 2023-2043.
- Key forecast uncertainties include the impact of rising prices, technological advancement in renewable energy sector, adoption of new consumer products and energy efficiency.

Section 1: Selecting Load Analysis Methods[1]

1.1 Identification of End-Use Measures[2]

See Volume 5: Demand Side Resource Analysis.

1.2 Purpose: Derivation of Data Set of Historical Values[3]

Evergy maintains a historical data set of load research and AMI data to support the Load forecast.

1.3 Analysis of Impacts of Implemented DSM And Demand-Side Rate on Load Forecasts[4]

See Volume 5: Demand Side Resource Analysis.

1.4 Reservation of Load Analysis in Historical Database[5]

Evergy preserves the historical data used to derive the load forecasts and provides this data in work papers and within the forecasting models.

Section 2: Historical Database for Load Analysis[6]

2.1 Customer Class Detail[7]

Evergy Metro (KS Metro and MO 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,

[1] 20 CSR 4240-22.030(1)
[2] 20 CSR 4240-22.030(1)(A)
[3] 20 CSR 4240-22.030(1)(B)
[4] 20 CSR 4240-22.030(1)(C)
[5] 20 CSR 4240-22.030(1)(D)
[6] 20 CSR 4240-22.030(2)
[7] 20 CSR 4240-22.030(2)(A)

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[8]

2.2.1 Actual and Weather Normalized Energy, And Number of Customers[9]

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[10]

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[11]

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

2.3 Load Component Detail[12]

2.3.1 Units Component[13]

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

[8] 20 CSR 4240-22.030(2)(B)
[9] 20 CSR 4240-22.030(2)(B)(1)
[10] 20 CSR 4240-22.030(2)(B)(2)
[11] 20 CSR 4240-22.030(2)(B)(3)
[12] 20 CSR 4240-22.030(2)(C)
[13] 20 CSR 4240-22.030(2)(C)(1)

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[14]

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[15]

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

[14] 20 CSR 4240-22.030(2)(C)(2)
[15] 20 CSR 4240-22.030(2)(C)(3)

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 June 2023.

Table 1: WN Model for MO Metro Residential Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	20.988	0.771	27.206	0.00%		Constant term
mWthrRevPD.HDD55	0.638	0.010	61.649	0.00%		
mWthrRevPD.CDD65	1.629	0.049	33.160	0.00%		
mWthrRevPD.CDD75	0.256	0.131	1.957	5.22%		
mBin.Feb	-0.576	0.240	-2.398	1.77%		
mBin.Jun	-1.642	0.223	-7.374	0.00%		
mBin.Nov	-0.870	0.227	-3.832	0.02%		
mBin.Jul12	-1.920	0.819	-2.343	2.04%		
ResAvgUsePD.Nov09	2.141	0.766	2.796	0.59%		
ResAvgUsePD.BeforeMay18	1.115	0.206	5.418	0.00%		
ResAvgUsePD.CCBCalib	-0.196	0.026	-7.551	0.00%		
ResAvgUsePD.COVID	0.645	0.210	3.068	0.26%		
ResAvgUsePD.Mar21	2.606	0.746	3.493	0.06%		
ResAvgUsePD.sum21	-3.562	0.457	-7.802	0.00%		
ResAvgUsePD.May22	-1.699	0.747	-2.275	2.43%		
ResAvgUsePD.Aug22	-2.154	0.762	-2.826	0.53%		
ResAvgUsePD.Sept22	-1.941	0.756	-2.568	1.12%		

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

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	16.076	3.630	4.429	0.00%		Constant term
mWthrRevPD.HDD50	0.616	0.034	18.095	0.00%		
mWthrRevPD.CDD65	1.424	0.048	29.887	0.00%		
ComSmlAvgUsePD.Dec11toDec14	-1.101	0.463	-2.376	1.88%		
ComSmlAvgUsePD.Jul09	4.326	2.277	1.900	5.94%		
ComSmlAvgUsePD.Feb15	-4.617	2.260	-2.042	4.28%		
ComSmlAvgUsePD.Jun17	-4.448	2.286	-1.946	5.35%		
mBin.TrendAfterYr12	0.957	0.115	8.333	0.00%		
ComSmlAvgUsePD.BeforeMay18	-5.391	0.825	-6.535	0.00%		
ComSmlAvgUsePD.CalibCCB	-5.647	0.890	-6.345	0.00%		
ComSmlAvgUsePD.CalibCov	-5.900	1.128	-5.230	0.00%		
ComSmlAvgUsePD.Mar19	0.705	2.240	0.314	75.36%		
mBin.Feb	1.730	0.742	2.333	2.10%		
mBin.Jun	-2.587	0.668	-3.871	0.02%		
mBin.Jul	-1.882	0.754	-2.496	1.36%		
mBin.Oct	2.108	0.647	3.257	0.14%		

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

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	11550611.833	403487.024	28.627	0.00%		Constant term
mWthrRevPD.HDD55	66964.983	3579.766	18.707	0.00%		
mWthrRevPD.CDD60	159172.531	5318.770	29.927	0.00%		
mBin.Mar	373251.907	75430.074	4.948	0.00%		
mBin.May	146416.932	82313.872	1.779	7.73%		
mBin.Aug	361906.373	97166.313	3.725	0.03%		
mBin.Sep	240614.183	86472.216	2.783	0.61%		
mBin.Oct	592285.431	80093.357	7.395	0.00%		
ComBigSalesPD.Aug15	-433488.408	268335.116	-1.615	10.83%		
ComBigSalesPD.Jun16	-309211.376	262081.685	-1.180	24.00%		
ComBigSalesPD.Jul17	792655.905	266888.217	2.970	0.35%		
ComBigSalesPD.Nov17	-1685311.749	263225.295	-6.403	0.00%		
ComBigSalesPD.Jun18	-155664.688	265624.603	-0.586	55.87%		
ComBigSalesPD.BeforeMay18	259692.142	93159.489	2.788	0.60%		
mBin.TrendAfterYr12	-106123.886	12681.102	-8.369	0.00%		
ComBigSalesPD.Jun19	-204740.277	262537.593	-0.780	43.67%		
ComBigSalesPD.Feb19	816859.467	265288.698	3.079	0.25%		
ComBigSalesPD.CalibCov	-1021741.797	133538.832	-7.651	0.00%		
ComBigSalesPD.Aug19	-300380.297	270091.052	-1.112	26.79%		
ComBigSalesPD.Sep19	1185767.255	268855.251	4.410	0.00%		

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

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	4691022.915	281731.787	16.651	0.00%		Constant term
mWthrRevPD.CDD60	30383.500	5796.965	5.241	0.00%		
IndSalesPD.Feb09	-1564695.752	534013.444	-2.930	0.39%		
IndSalesPD.Mar09	1455468.407	533717.441	2.727	0.71%		
IndSalesPD.Feb10	-1376475.825	532655.473	-2.584	1.07%		
IndSalesPD.Mar10	1921403.104	532548.387	3.608	0.04%		
IndSalesPD.Jun09	-894521.785	532935.350	-1.678	9.53%		
IndSalesPD.Jul09	727078.438	535356.484	1.358	17.64%		
IndSalesPD.Dec15	-818016.046	528870.803	-1.547	12.40%		
IndSalesPD.Nov17	2330462.562	528751.593	4.407	0.00%		
mBin.TrendVar	-29640.505	10552.013	-2.809	0.56%		

Table 5: WN Model for KS Metro Residential Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	29.258	0.676	43.290	0.00%		Constant term
mWthrRevPD.HDD50	0.211	0.056	3.787	0.02%		
mWthrRevPD.HDD55_seas	0.497	0.049	10.077	0.00%		
mWthrRevPD.CDD65	1.607	0.047	34.173	0.00%		
mWthrRevPD.CDD60_seas	0.371	0.034	10.972	0.00%		
mBin.TrendVar	-0.327	0.022	-14.814	0.00%		
ResAvgUsePD.Jul08	2.639	0.723	3.651	0.04%		
ResAvgUsePD.Sep09	-1.666	0.716	-2.327	2.12%		
ResAvgUsePD.Dec09	1.801	0.720	2.501	1.34%		
ResAvgUsePD.Feb10	1.398	0.723	1.935	5.47%		
ResAvgUsePD.Jul11	4.197	0.721	5.825	0.00%		
mBin.Aug12	-2.454	0.729	-3.368	0.10%		
ResAvgUsePD.Dec15	1.495	0.720	2.076	3.95%		
ResAvgUsePD.Jun16	2.023	0.721	2.805	0.57%		
ResAvgUsePD.Sep17	1.863	0.719	2.593	1.04%		
ResAvgUsePD.CCB	0.734	0.217	3.381	0.09%		
ResAvgUsePD.Aug18	-2.332	0.732	-3.185	0.18%		
ResAvgUsePD.Aug19	-1.759	0.732	-2.403	1.74%		
ResAvgUsePD.Calib	1.332	0.211	6.317	0.00%		
ResAvgUsePD.sum21	-4.067	0.441	-9.220	0.00%		
ResAvgUsePD.Aug22	-3.108	0.731	-4.250	0.00%		

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

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	25.085	3.560	7.047	0.00%		Constant term
mWthrRevPD.HDD55	0.447	0.049	9.185	0.00%		
mWthrRevPD.CDD65	1.145	0.089	12.819	0.00%		
mBin.TrendAfterYr12	0.292	0.148	1.973	5.03%		
mBin.AfterYr12	2.274	1.093	2.081	3.91%		
ComSmlAvgUsePD.Oct11	-3.074	4.558	-0.674	50.11%		
ComSmlAvgUsePD.Oct13	-5.888	4.565	-1.290	19.90%		
ComSmlAvgUsePD.CalibCCB	4.109	1.676	2.451	1.54%		
ComSmlAvgUsePD.CalibCov	4.132	2.109	1.959	5.20%		
ComSmlAvgUsePD.CalibSml	0.511	1.141	0.448	65.45%		

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

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	-10096454734.171	44095732522042.300	-0.000	99.98%		Constant term
mWthrRevPD.HDD55	20639.124	29289.793	0.705	48.22%		
mWthrRevPD.CDD60	175074.889	60535.188	2.892	0.44%		
ComBigSalesPD.BeforeApr13	-668573.942	428374.763	-1.561	12.08%		
ComBigSalesPD.CalibCCB	132207.201	424730.404	0.311	75.60%		
ComBigSalesPD.Jun18	-779018.523	1057746.048	-0.736	46.26%		
ComBigSalesPD.Aug18	221681.467	1021815.710	0.217	82.86%		
ComBigSalesPD.Sep18	-898955.438	1023852.308	-0.878	38.14%		
ComBigSalesPD.CalibCov	-480428.099	418289.029	-1.149	25.26%		
SAR(1)	1.000	0.157	6.363	0.00%		

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

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	1994509.875	323432.295	6.167	0.00%		Constant term
mWthrRevPD.CDD60	6618.555	1247.755	5.304	0.00%		
IndSalesPD.Mar09	234480.337	53898.592	4.350	0.00%		
IndSalesPD.Mar10	206785.208	53883.183	3.838	0.02%		
mBin.TrendVar	-49232.792	12520.288	-3.932	0.01%		
IndSalesPD.May18	-77811.415	53868.465	-1.444	15.04%		
AR(1)	0.877	0.045	19.326	0.00%		

2.4 Assessments[16]

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

[16] 20 CSR 4240-22.030(2)(D)

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[17]

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 1.2% for 2012-2022.

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 2022 averaged 1.4%.

Commercial Big (MGS, LGS, LP) saw rapid customer growth in the late 2000s, averaging 2.4% from 2006 to 2010. Since then, many customers have switched classes due to rate cases or consolidations, resulting in somewhat sporadic customer counts. Over the last 3 years, 2019-2022, customers have declined slightly -0.7%.

Industrial customers have gradually declined through the recent couple of decades, averaging -1.4% growth since 2010.

Residential MWh use per customer reveals a very slight downward trend (-0.8%) over the last 10 years 2012-2022. The downward trend in is due in part to increasing efficiency of air conditioning units and lighting among other things, partially offset by increase in electric space heat saturation.

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[17] 20 CSR 4240-22.030(2)(D)(1)

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 (3.2%) and non-summer (3.3%) 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 (-0.8) 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 increased slightly for both summer (0.4%) and non-summer (0.3%) 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[18]

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 July 2021 through June 2023, 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.

[18] 20 CSR 4240-22.030(2)(D)(2)

Figure 1: MO Metro Residential Daily Energy vs Average Temp

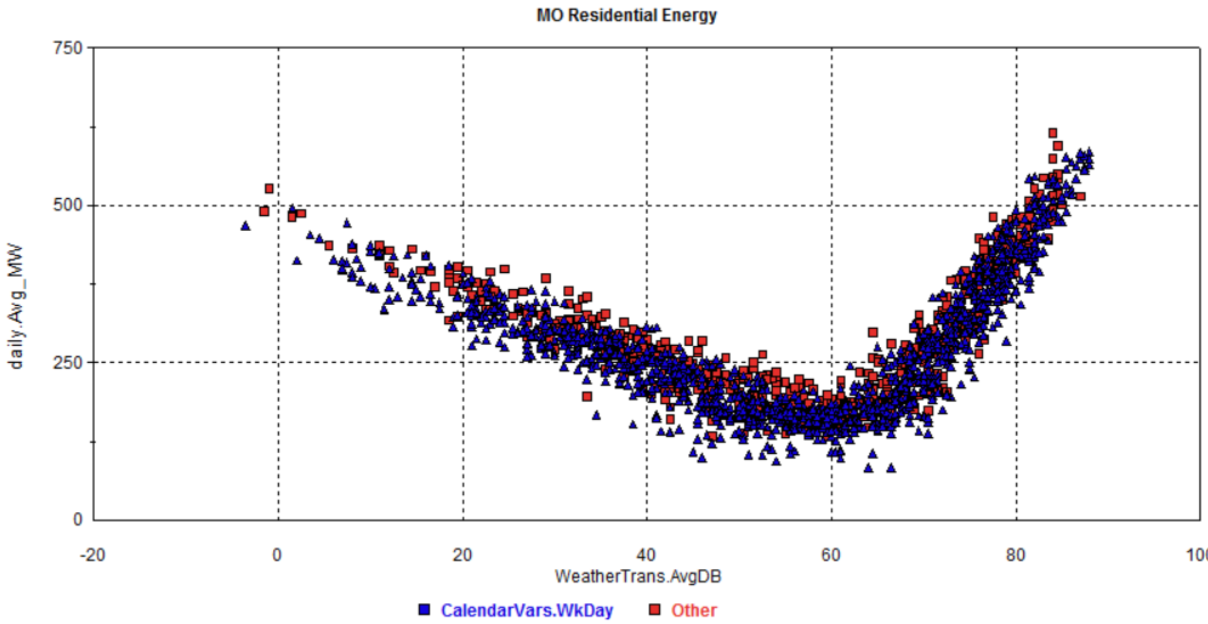


Figure 2: MO Metro Residential Daily Peak Demand vs Average Temp

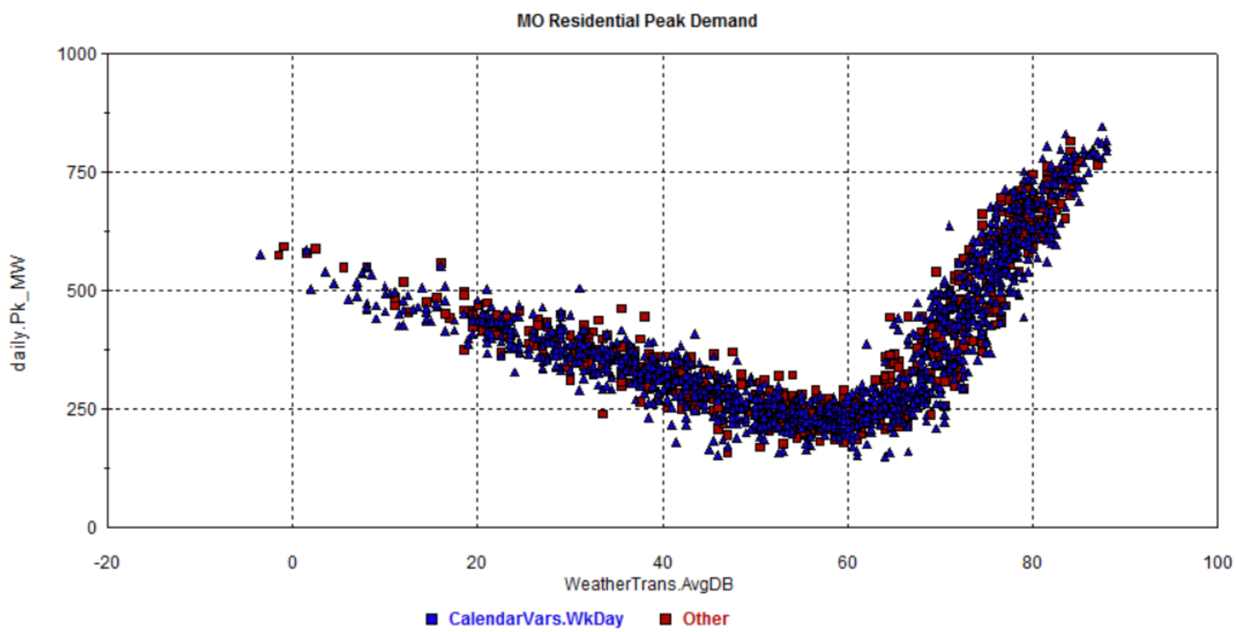


Figure 3: MO Metro Small General Service Daily Energy vs Average Temp

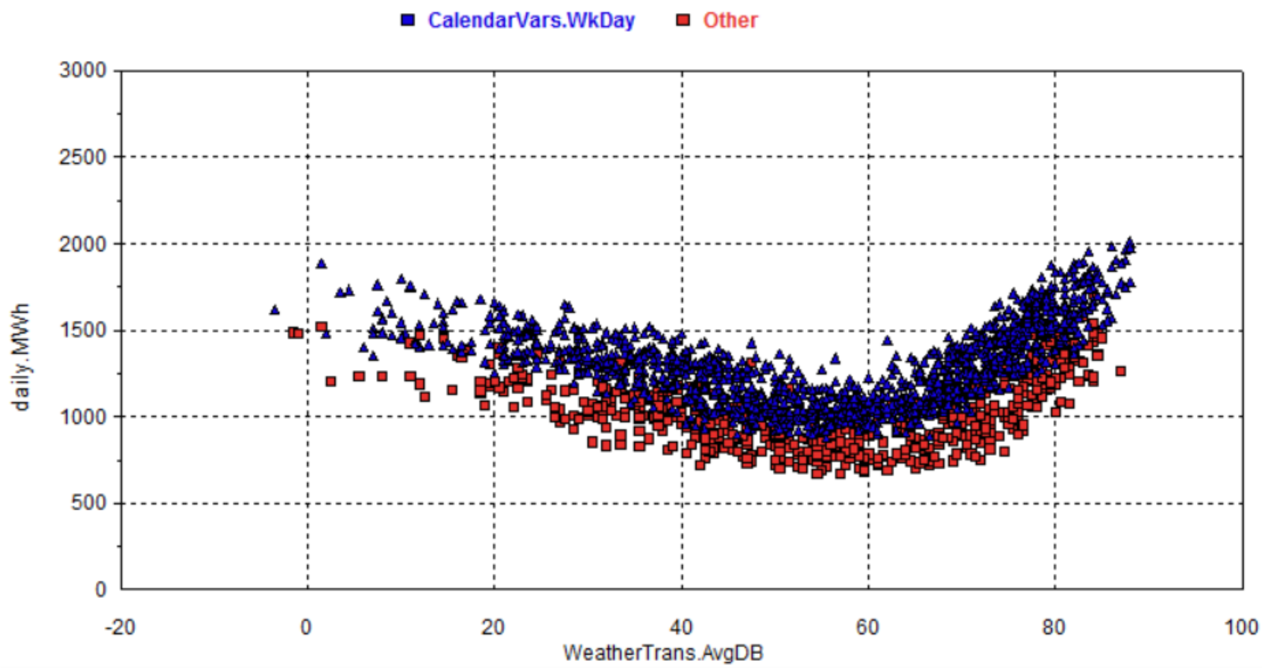


Figure 4: MO Metro Small General Service Daily Peak vs Average Temp

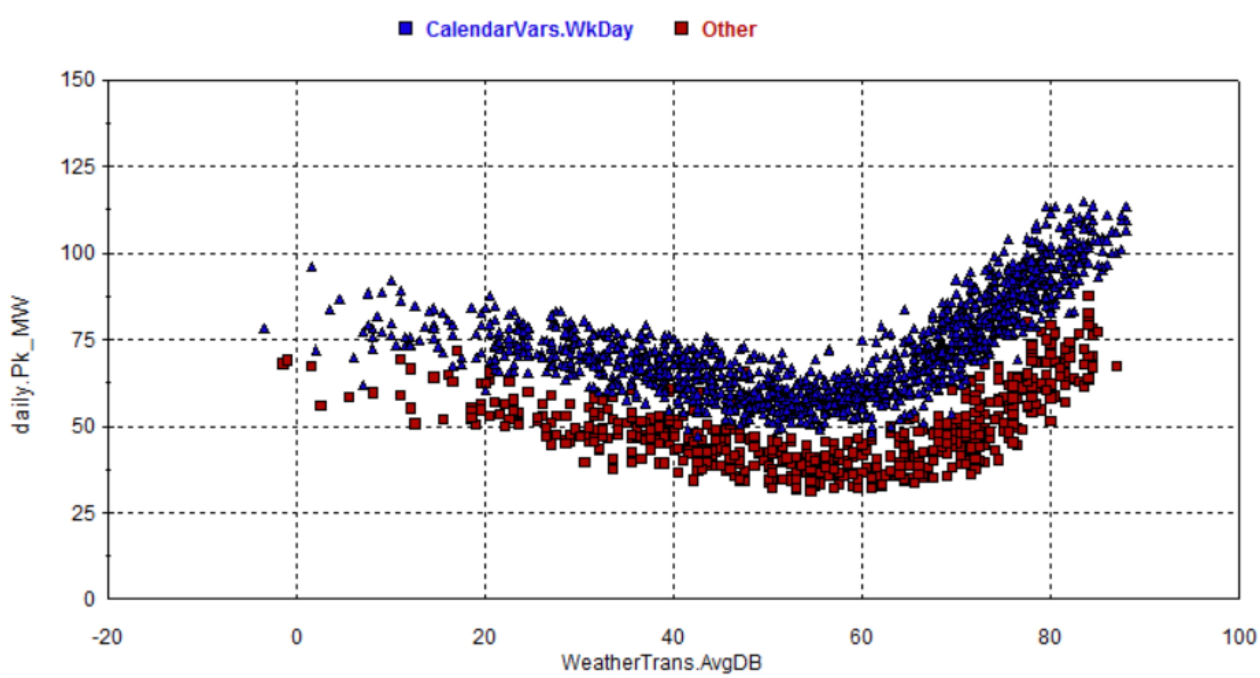


Figure 5: MO Metro Medium General Service Daily Energy vs Average Temp

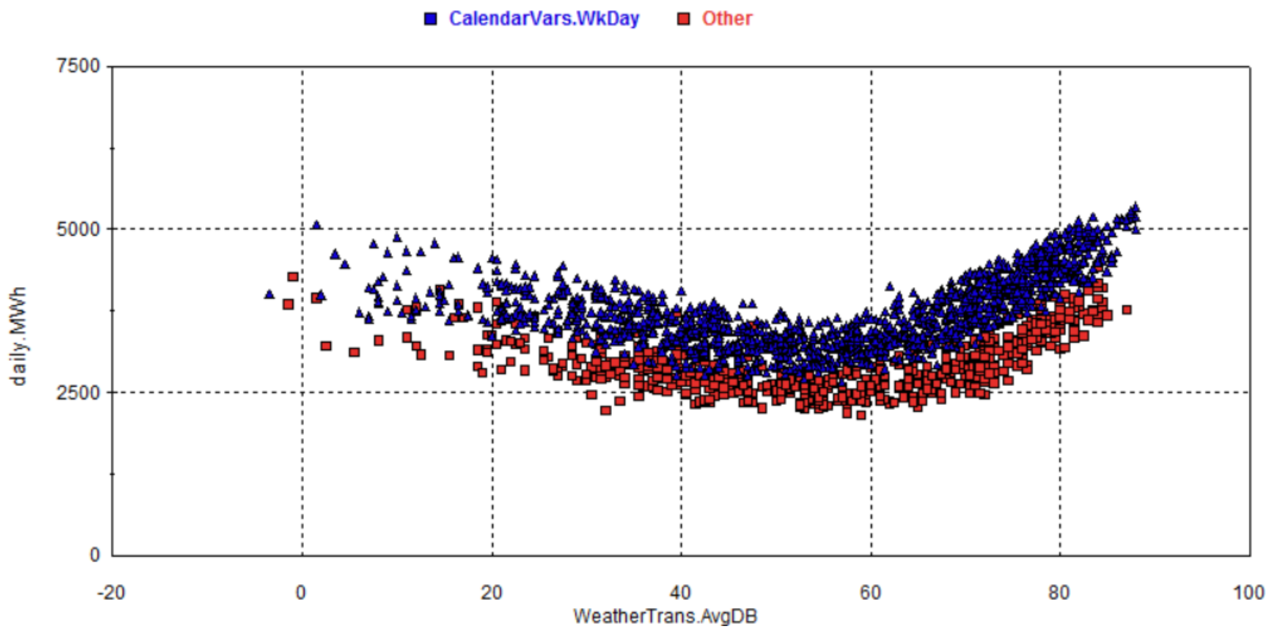


Figure 6: MO Metro Medium General Service Daily Peak Demand vs Average Temp

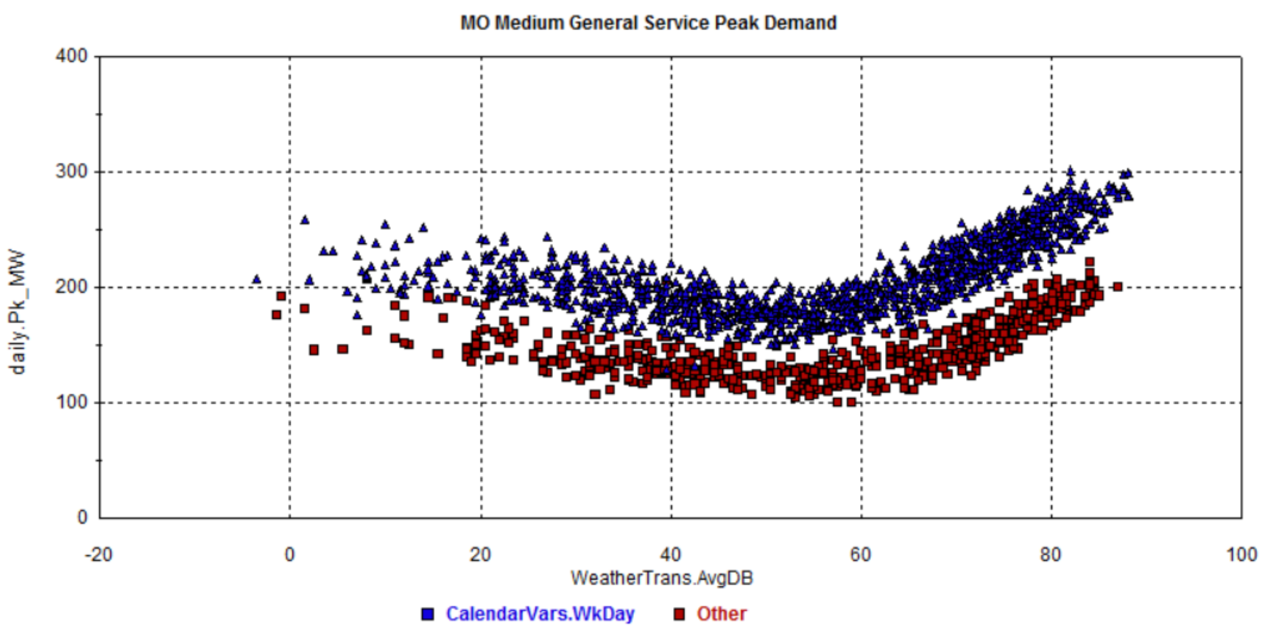


Figure 7: MO Metro Large General Service Daily Energy vs Average Temp

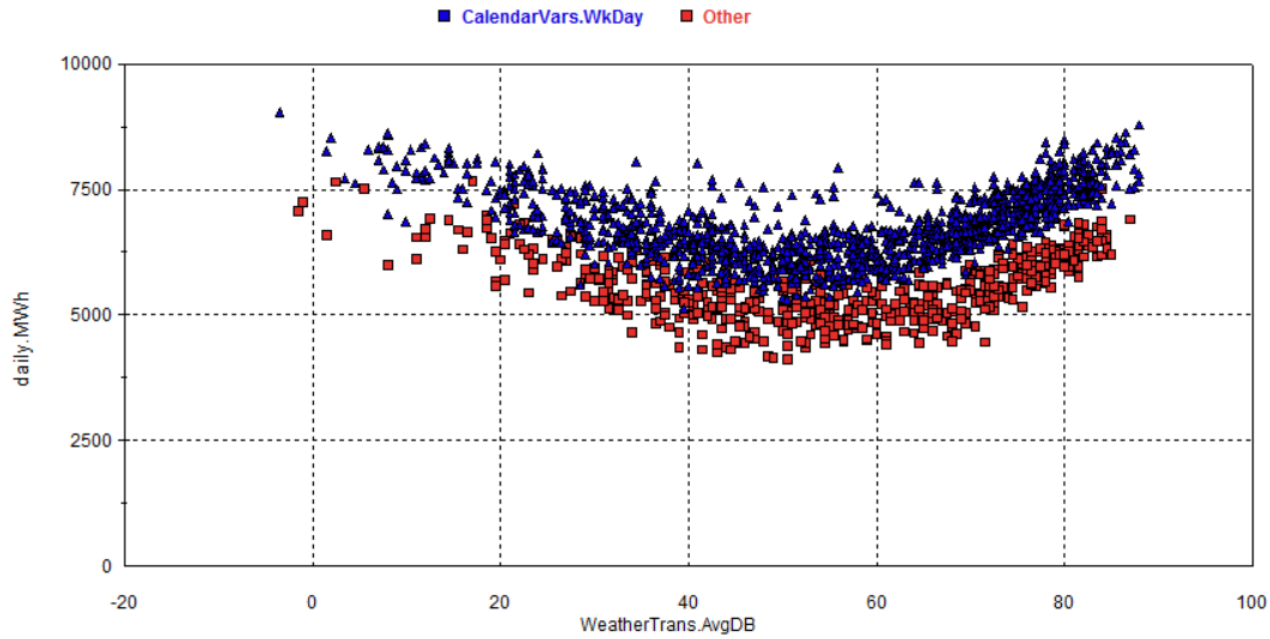


Figure 8: MO Metro Large General Service Daily Peak Demand vs Average Temp

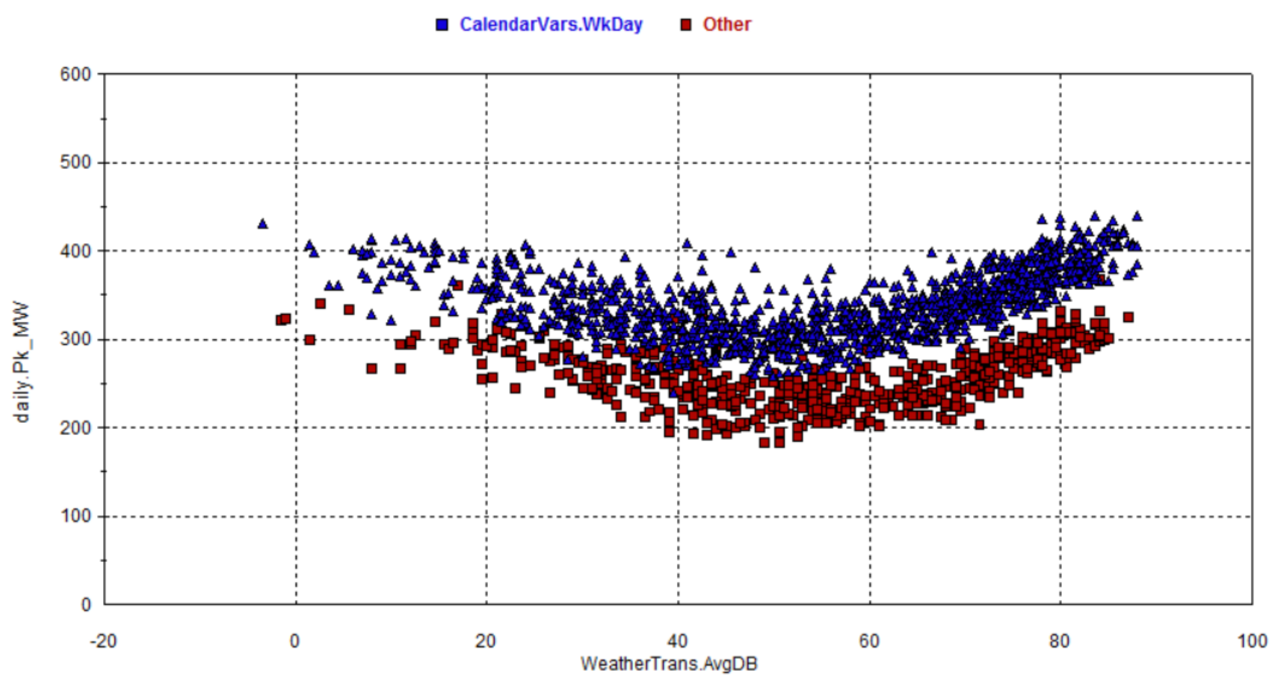


Figure 9: MO Metro Large Power Daily Energy vs Average Temp

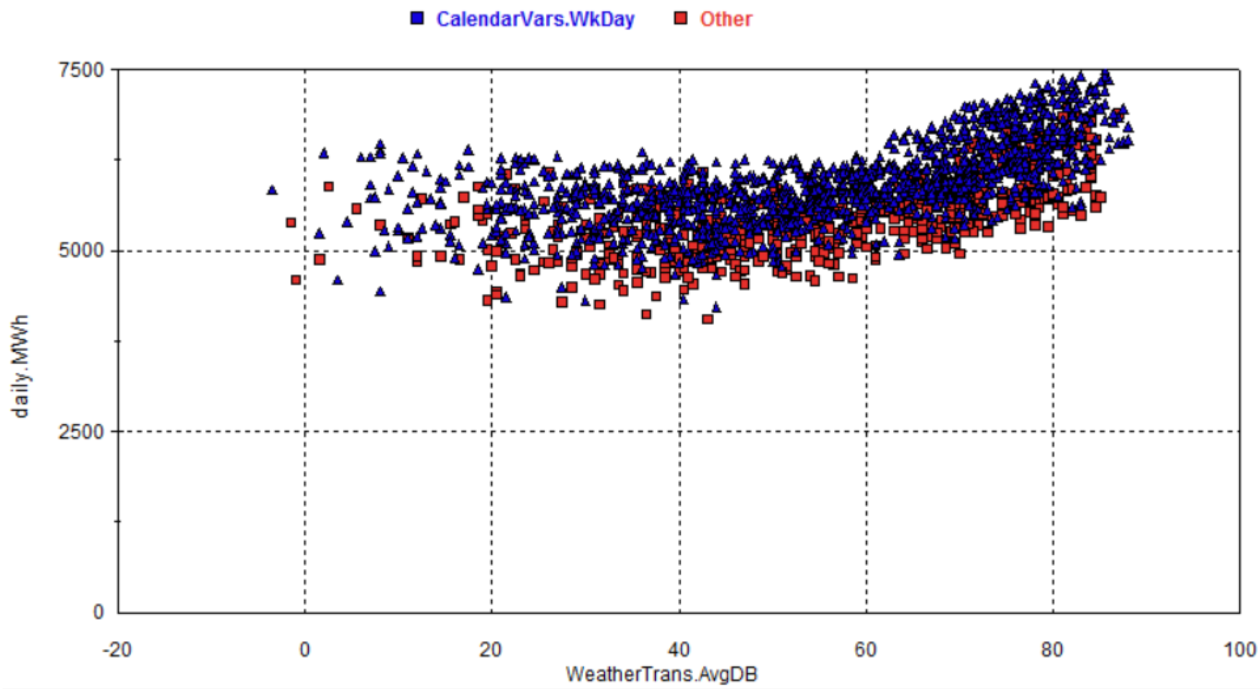


Figure 10: MO Metro Large Power Daily Peak Demand vs Average Temp

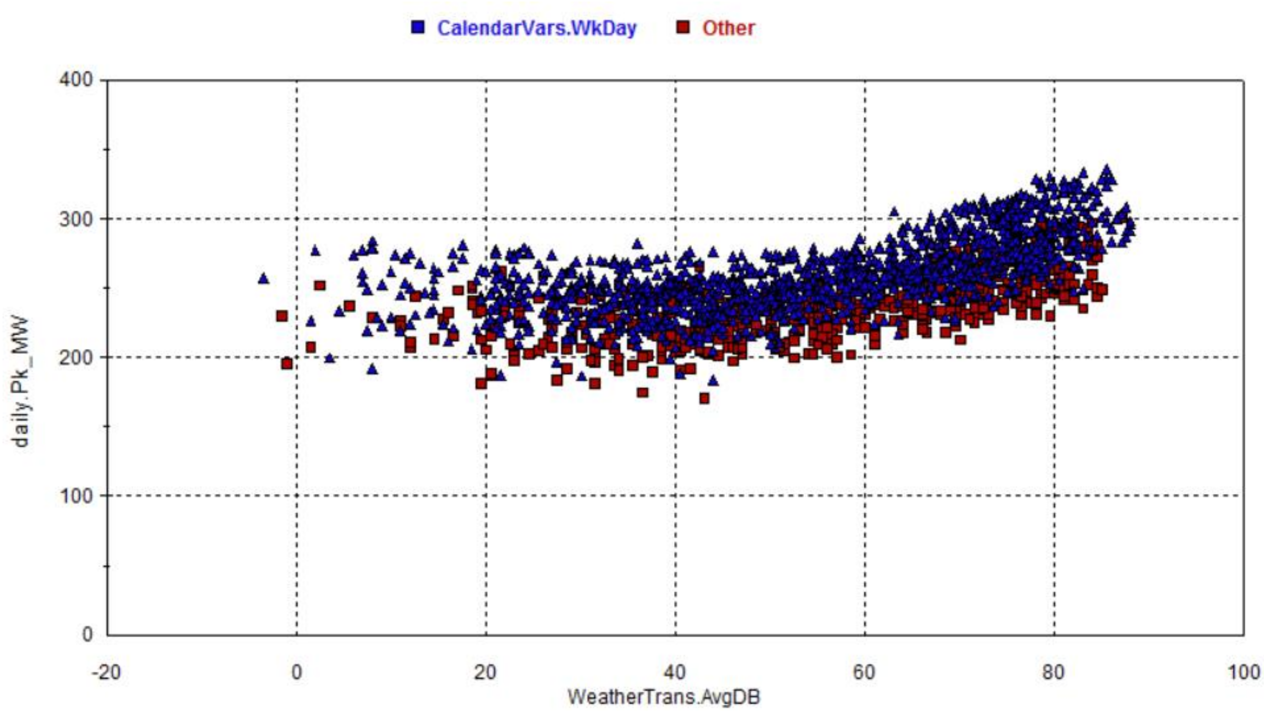


Figure 11: MO Metro Sales for Resale Daily Energy vs Average Temp

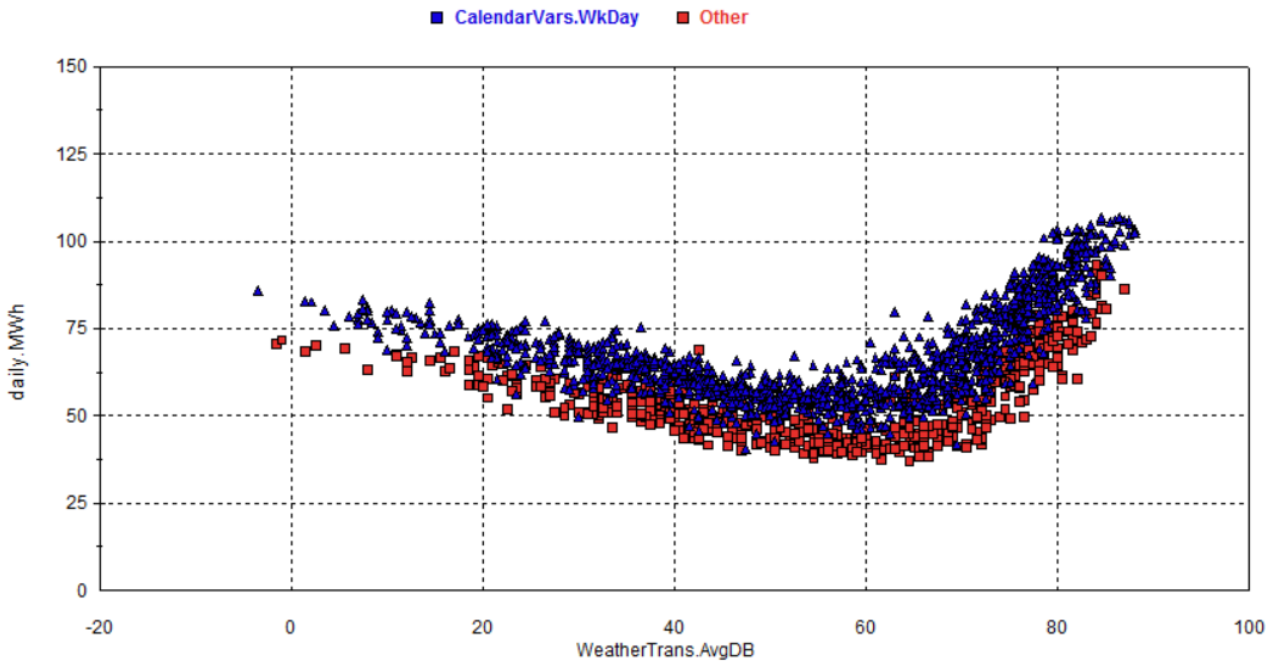


Figure 12: MO Metro Sales for Resale Daily Peak Demand vs Average Temp

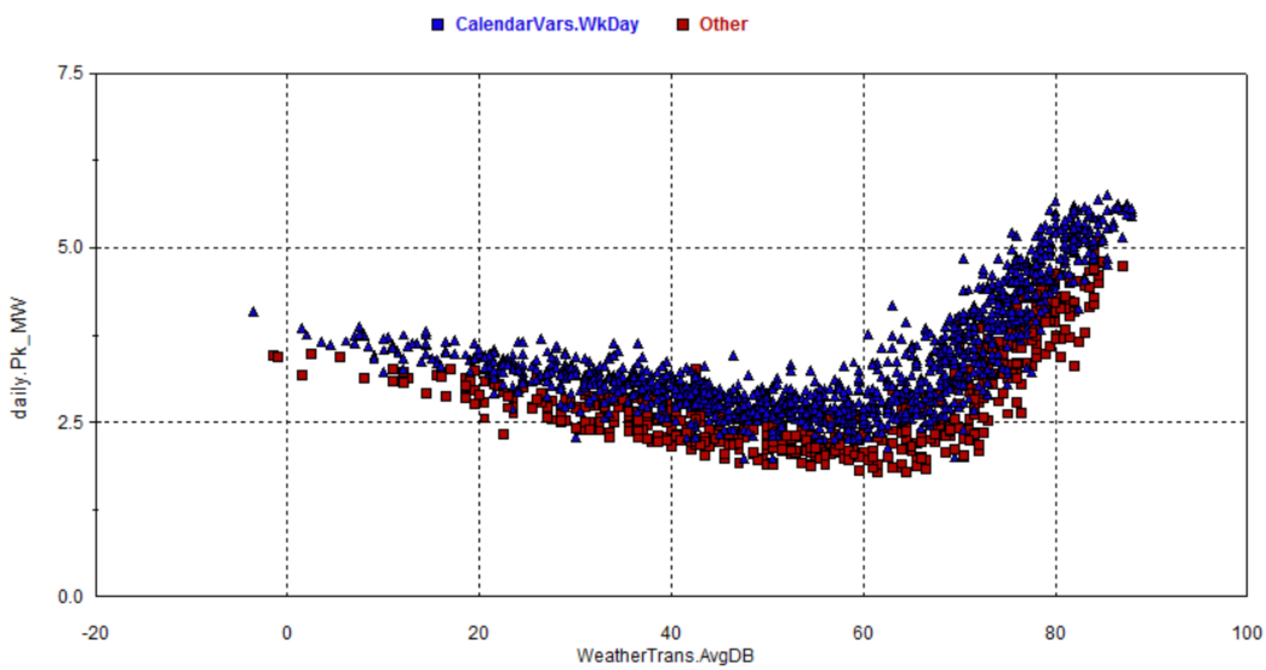


Figure 13: KS Metro Residential Daily Energy vs Average Temp

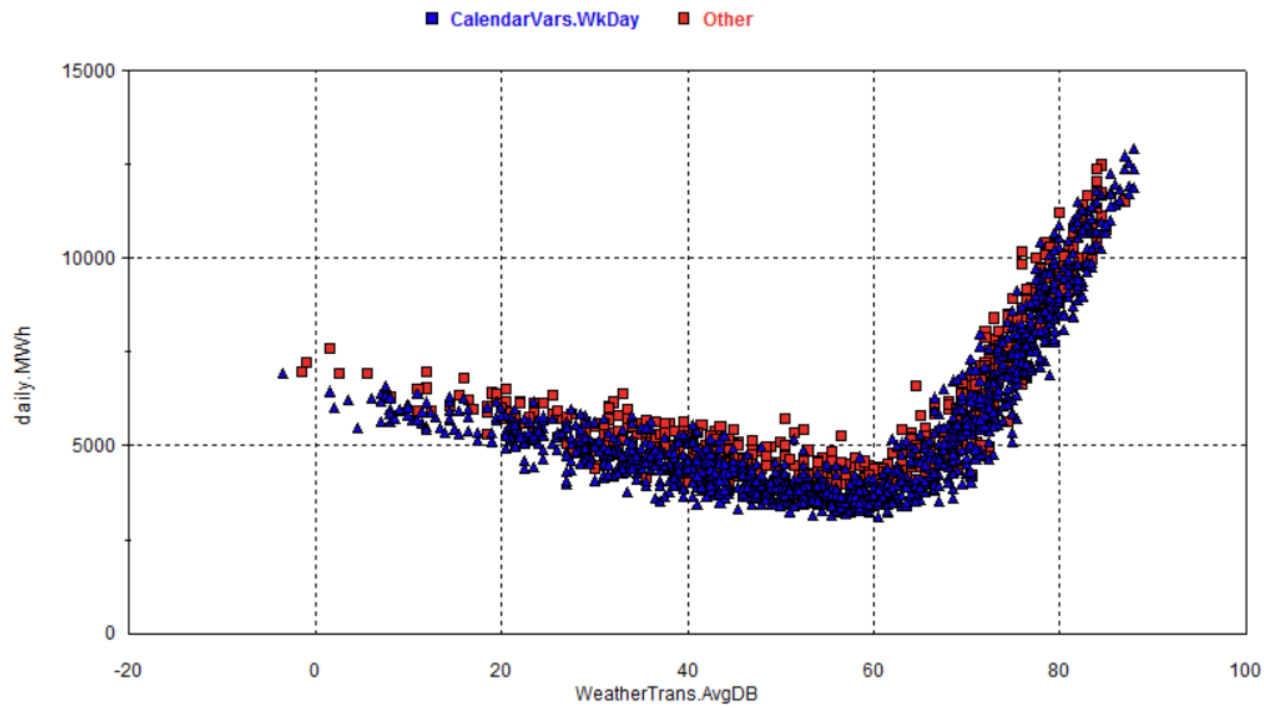


Figure 14: KS Metro Residential Daily Peak Demand vs Average Temp

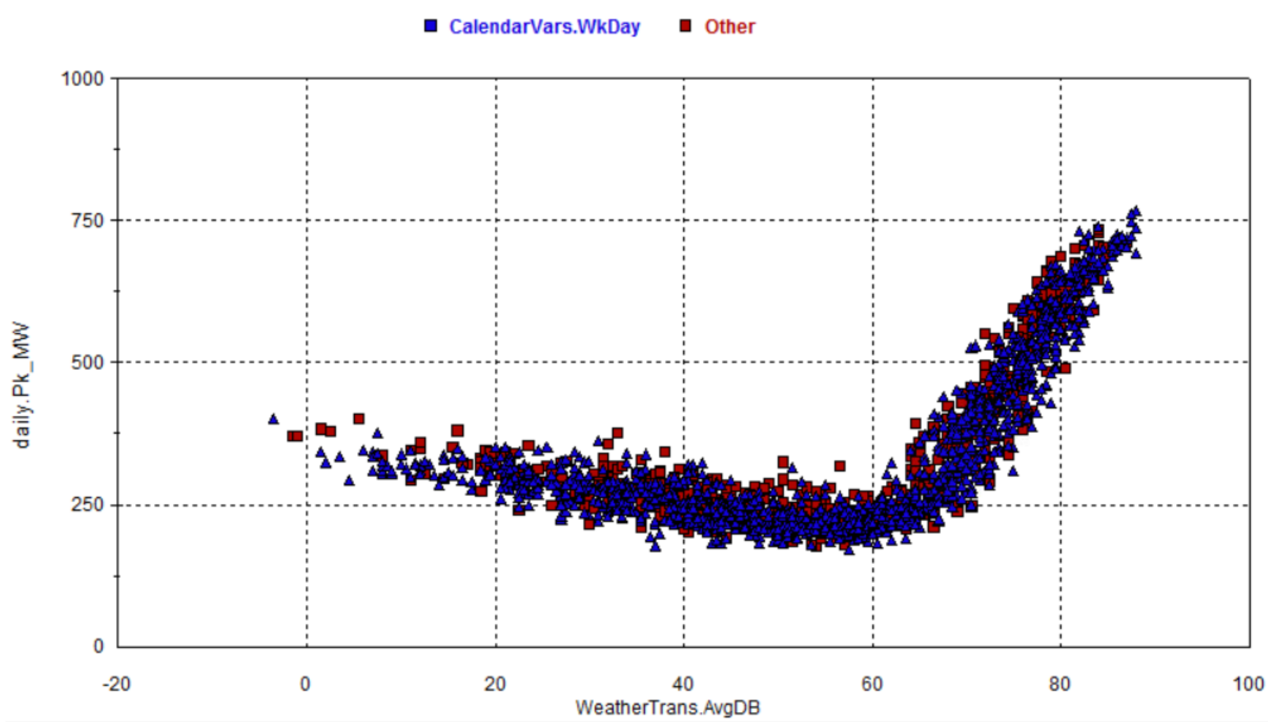


Figure 15: KS Metro Small General Service Daily Energy vs Average Temp

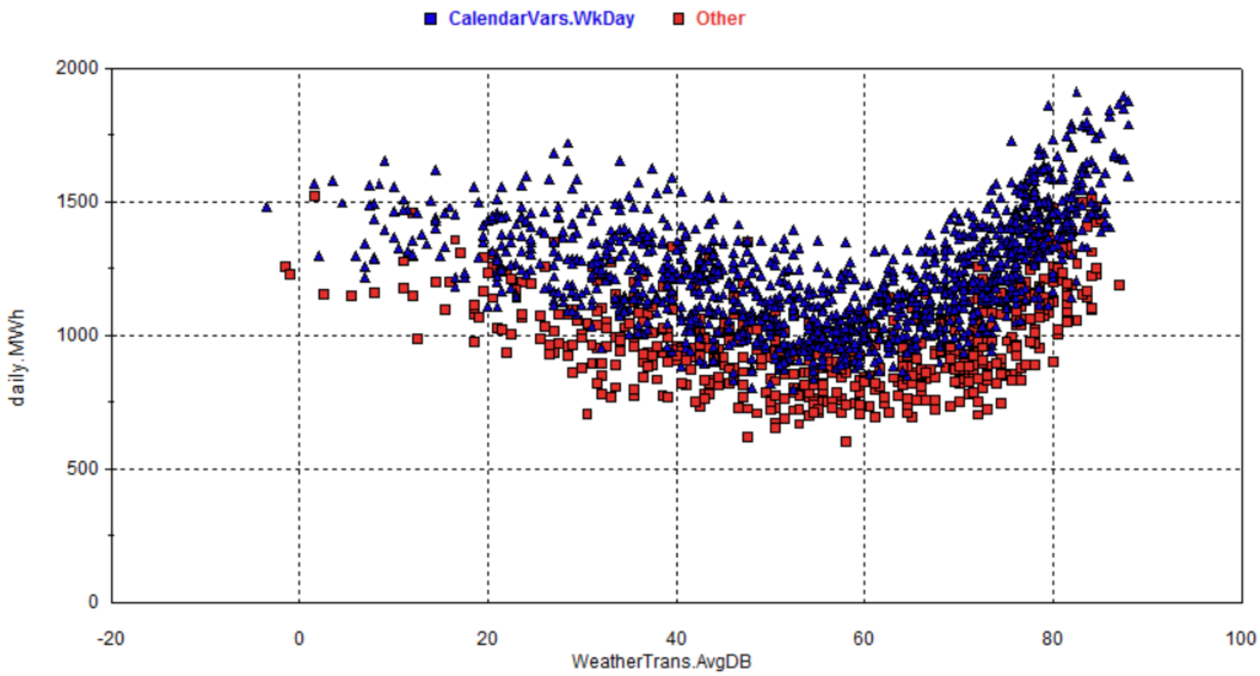


Figure 16: KS Metro Small General Service Daily Peak Demand vs Average Temp

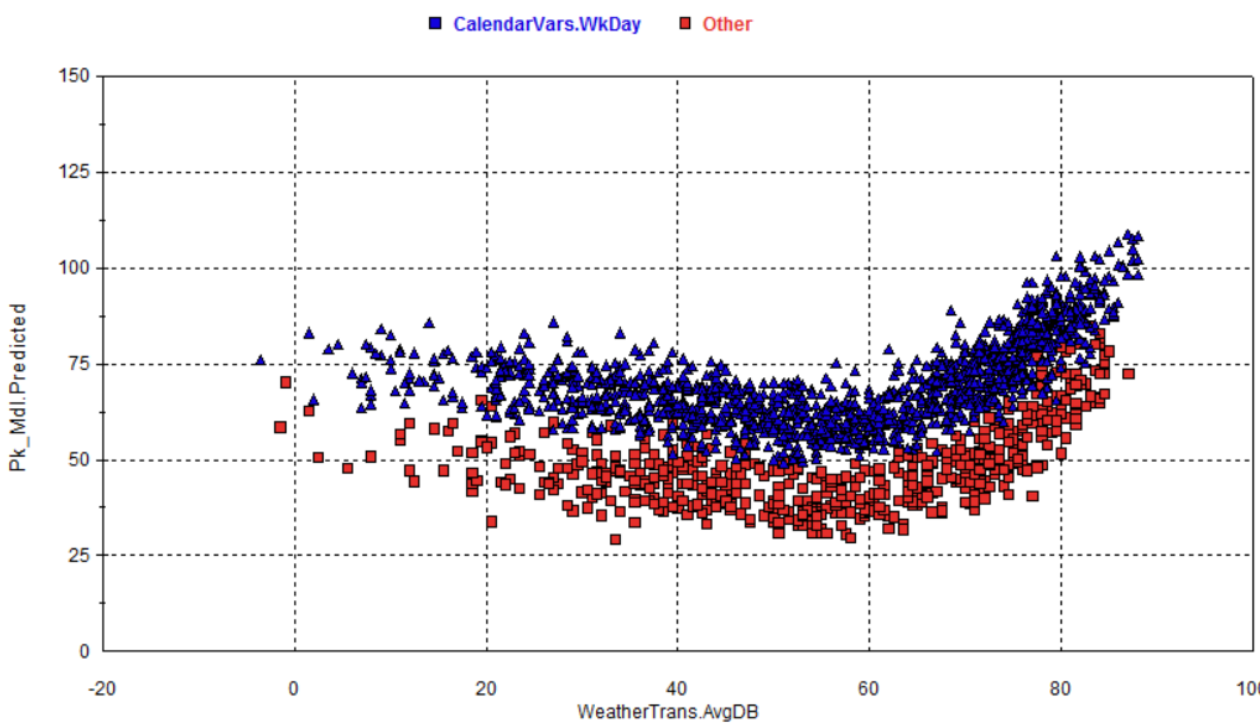


Figure 17: KS Metro Medium General Service Daily Energy vs Average Temp

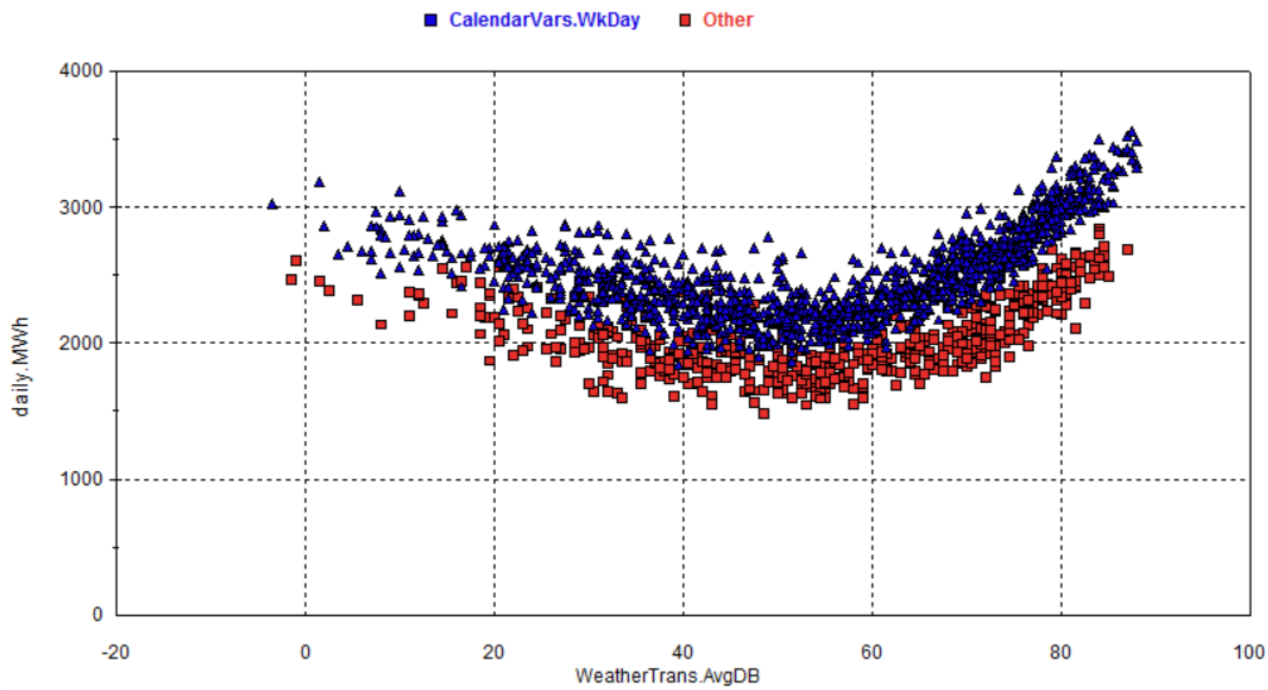


Figure 18: KS Metro Medium General Service Daily Peak Demand vs Average Temp

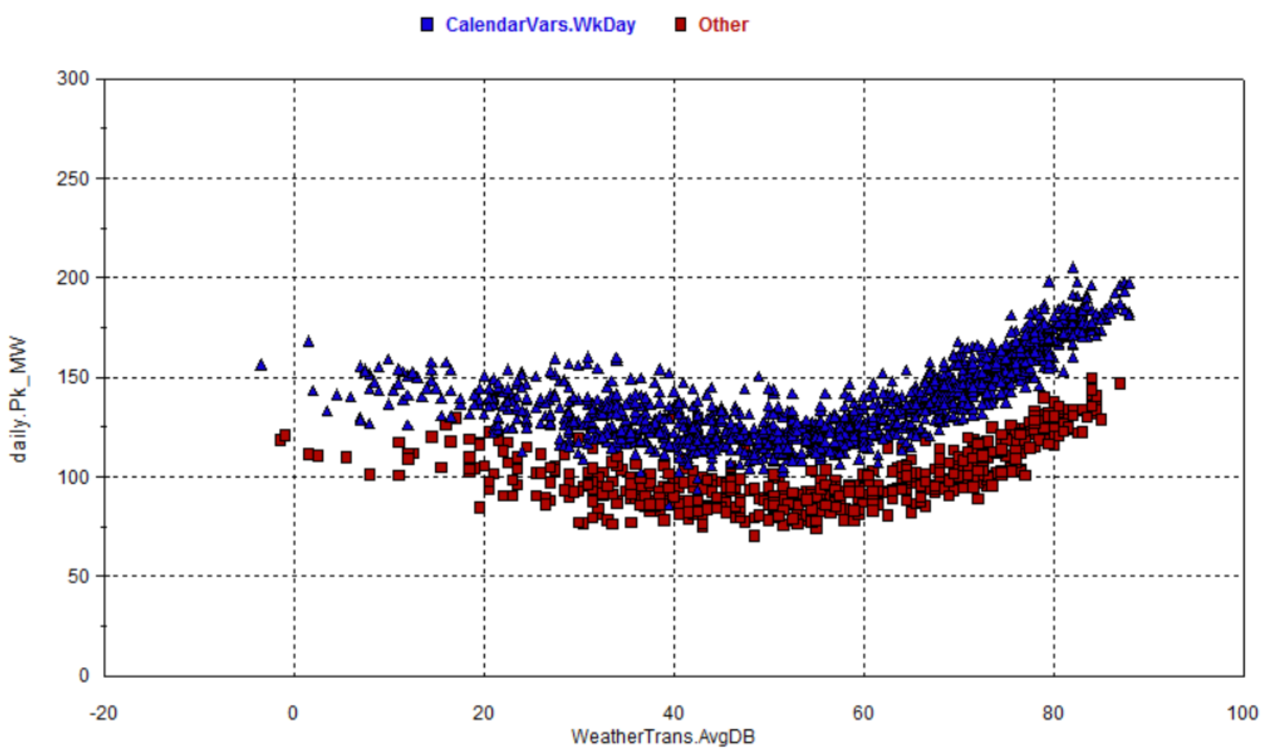


Figure 19**: KS Metro Large General Service Daily Energy vs Average Temp**

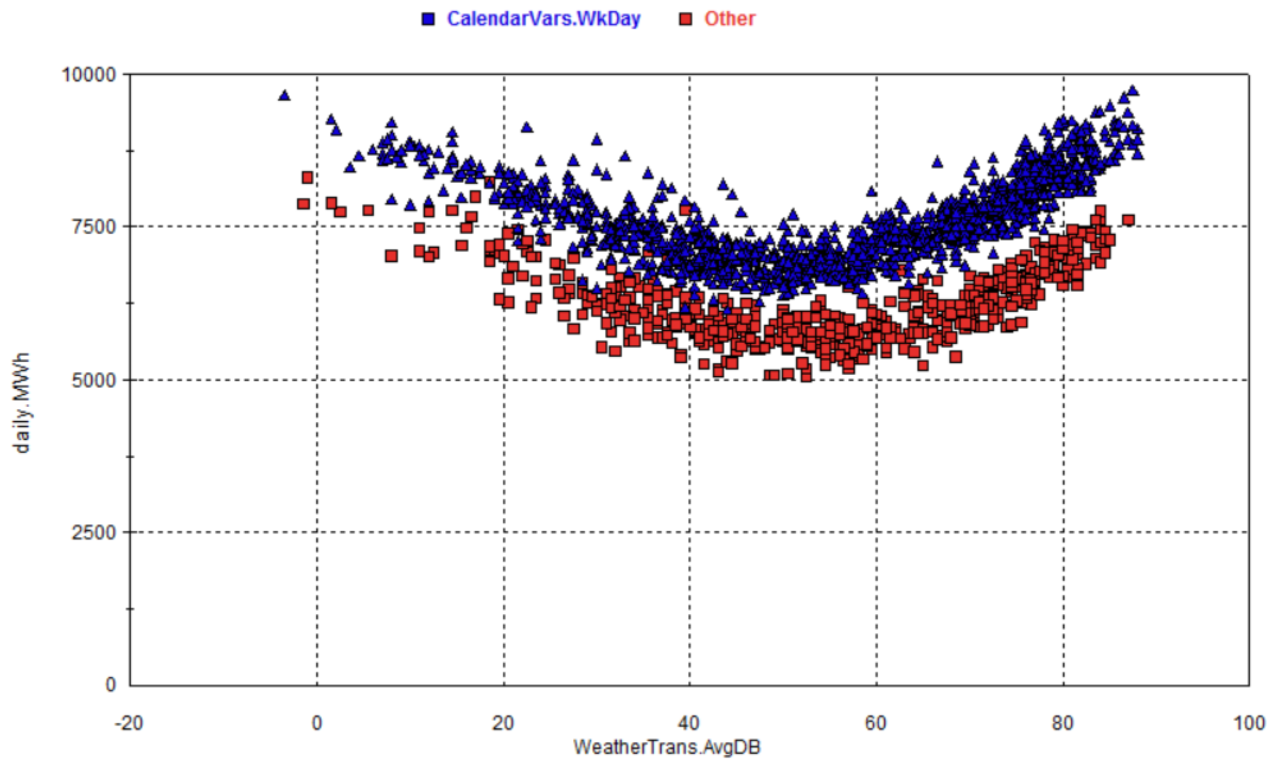


Figure 20: KS Metro Large General Service Daily Peak Demand vs Average Temp

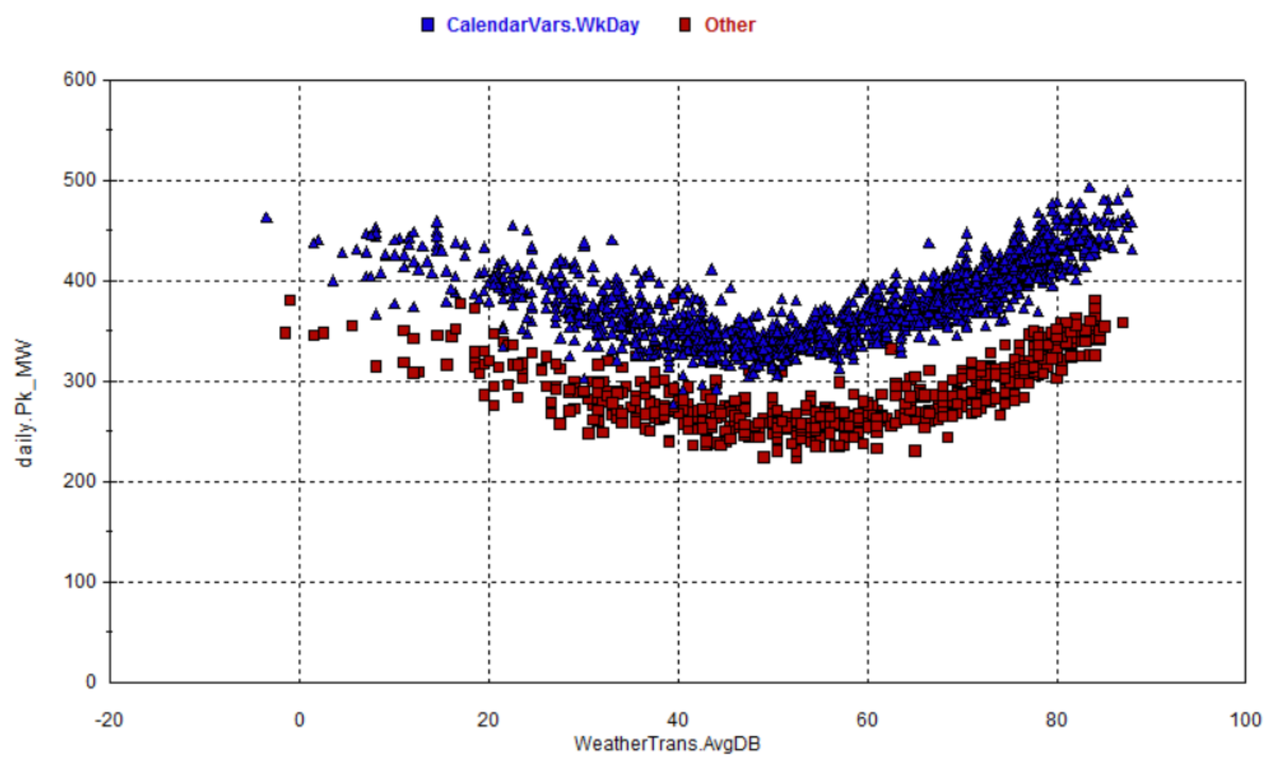


Figure 21: KS Metro Sales for Resale Daily Energy vs Average Temp

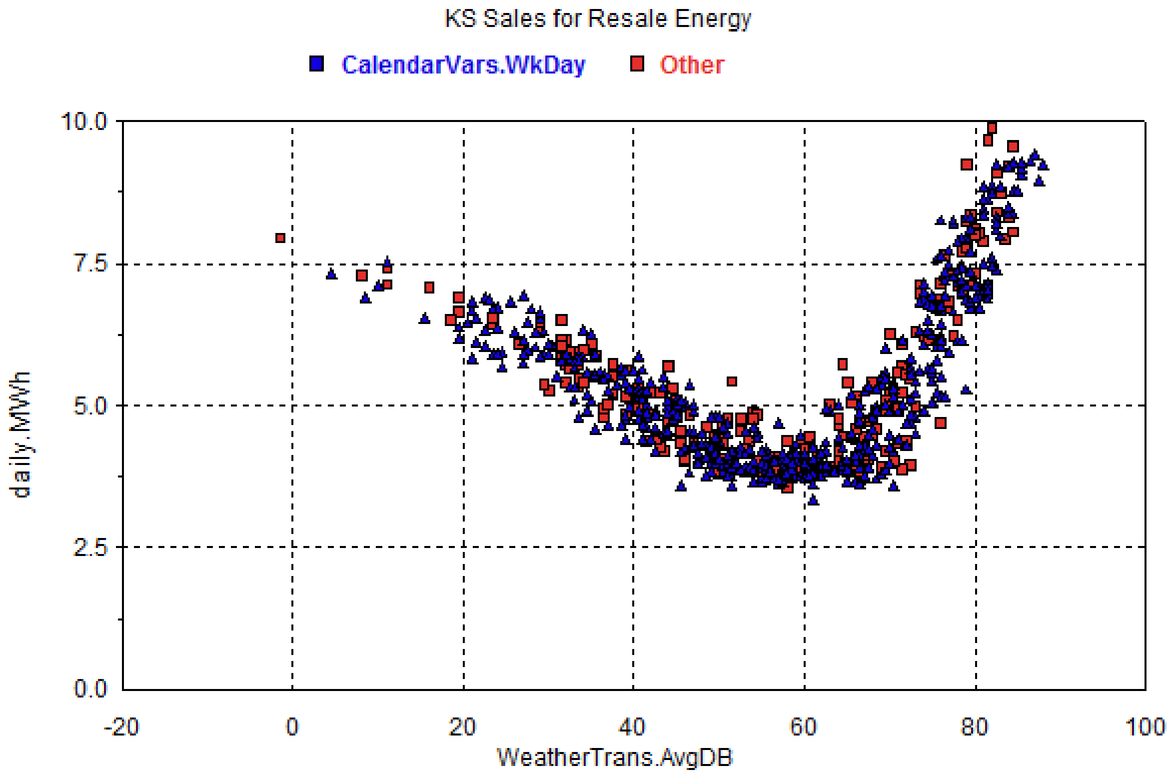
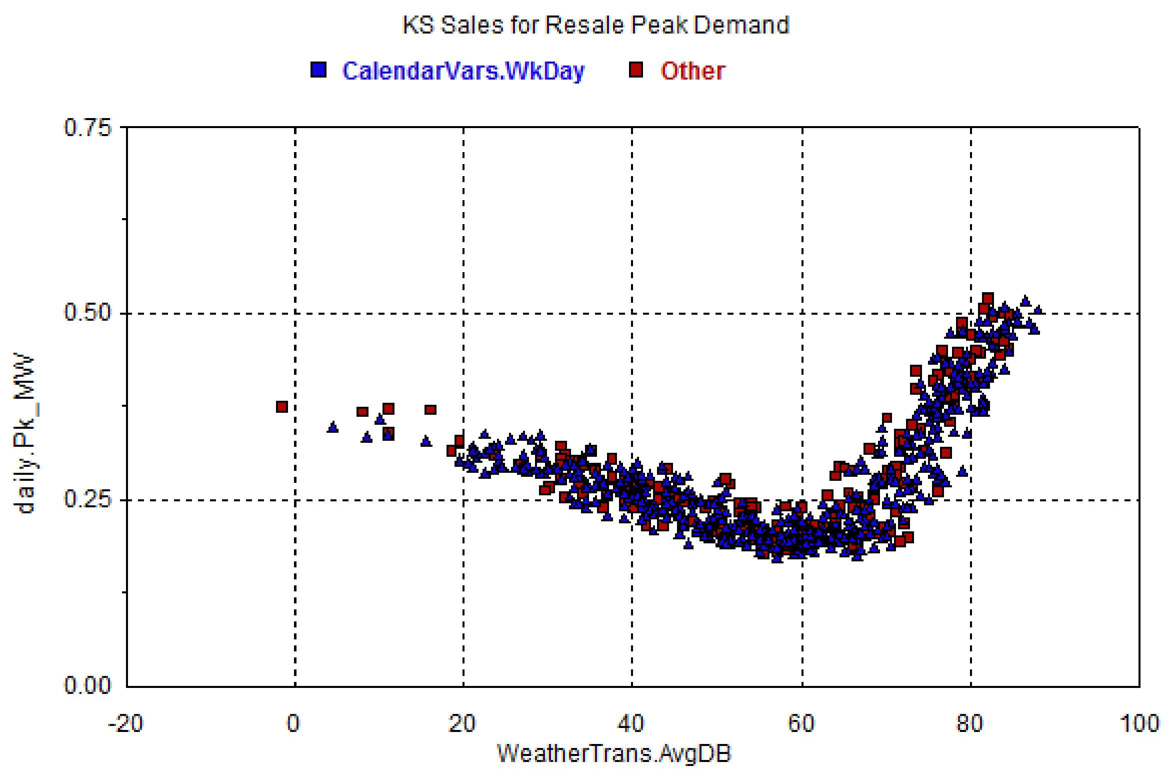


Figure 22: KS Metro Sales for Resale Daily Energy vs Average Temp



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

2.4.3 Plots Illustrating trends materially affecting electricity consumption[19]

Historical class plots of customers, kwh, average use, and peak are provided in *Appendix 3A1* and were discussed above in section *2.4.1 Historic End-Use Drivers of Energy Usage and Peak Demand.*

2.5 Adjustments to Historical Data Description and Documentation[20]

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

2.6 Length of Historical Database[21]

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.

[19] 20 CSR 4240-22.030(2)(D)(3)
[20] 20 CSR 4240-22.030(2)(E)
[21] 20 CSR 4240-22.030(2)(F)

Section 3: Analysis of Number of Units[22]

3.1 Identification of Explanatory Variables[23]

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 were tested 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.

[22] 20 CSR 4240-22.030(3)
[23] 20 CSR 4240-22.030(3)(A)

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[24]

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	Units	Definition
mBinary.Feb	1343.527	247.770	5.422	0.00%		
mBinary.Mar	1292.141	275.096	4.697	0.00%		
mBinary.Apr	1033.496	285.917	3.615	0.04%		
mBinary.May	1066.413	277.778	3.839	0.02%		
mBinary.Jun	503.796	248.570	2.027	4.42%		
mBinary.Jul	817.483	190.824	4.284	0.00%		
mBinary.Nov	427.260	146.026	2.926	0.39%		
RES_Cust.TrendVar	-17.517	7.350	-2.383	1.82%		
RES_Cust.Dec19	2117.680	574.405	3.687	0.03%		
RES_Cust.Jun21thruMar22	-1123.760	579.957	-1.938	5.43%		
AR(1)	0.952	0.031	30.951	0.00%		

24 20 CSR 4240-22.030(3)(B)

Table 10: MO Metro Small GS Commercial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	12831.974	314.726	40.772	0.00%		Constant term
Economics.GP_Non_Man	0.130	0.003	41.503	0.00%	N/A	
SML_Cust.Nov11	611.364	42.646	14.336	0.00%		
SML_Cust.CalibMay14thruMay18	-318.264	30.916	-10.295	0.00%		
SML_Cust.Oct20	266.735	46.696	5.712	0.00%		
mBinary.CalibCov	1266.347	106.670	11.872	0.00%		

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

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
mEcon.Population_log	787.337	1.203	654.521	0.00%		
mBinary.BeforeJul08	-394.232	11.330	-34.797	0.00%		
mBinary.Oct13	-151.089	37.416	-4.038	0.01%		
mBinary.Dec09	116.636	37.964	3.072	0.24%		
mBinary.Mar10	100.239	37.390	2.681	0.80%		
mBinary.TrendYR08_09	0.002	0.000	8.453	0.00%		
BIG_Cust.YR06	-102.414	14.261	-7.182	0.00%		
BIG_Cust.Dec08	165.685	37.950	4.366	0.00%		
BIG_Cust.Dec11	85.704	37.402	2.291	2.30%		
BIG_Cust.Dec16	-93.137	37.885	-2.458	1.48%		
BIG_Cust.Feb18	-100.169	37.564	-2.667	0.83%		
BIG_Cust.Apr18	-111.340	37.564	-2.964	0.34%		
BIG_Cust.CalibCCB	79.464	13.951	5.696	0.00%		
BIG_Cust.CalibSwitch1	0.001	0.000	5.388	0.00%		
BIG_Cust.CalibSwitch2	0.001	0.000	3.771	0.02%		
BIG_Cust.CalibSwitch3	-73.369	9.653	-7.601	0.00%		
BIG_Cust.CalibCov	-163.063	16.026	-10.175	0.00%		
BIG_Cust.Feb21	-261.206	13.825	-18.894	0.00%		
BIG_Cust.Feb21thruJul22	65.952	14.018	4.705	0.00%		
BIG_Cust.Jun22	-103.617	38.207	-2.712	0.73%		

Table 12: MO Metro Industrial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	6.056	6.984	0.867	38.69%		Constant term
IND_Cust.LagDep(1)	0.993	0.007	143.912	0.00%		
IND_Cust.Aug08	41.028	10.177	4.031	0.01%		
IND_Cust.Aug09	-35.832	10.258	-3.493	0.06%		
IND_Cust.May14	36.233	10.026	3.614	0.04%		
IND_Cust.Feb18	-35.183	10.695	-3.289	0.12%		
IND_Cust.Mar18	52.321	10.685	4.897	0.00%		
AR(1)	-0.399	0.066	-6.019	0.00%		

Table 13: KS Metro Residential Customers

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	48741.977	14369.244	3.392	0.08%		Constant term
Economics.Population	247.384	40.055	6.176	0.00%	N/A	
RES_Cust.LagDep(12)	0.351	0.062	5.659	0.00%		
mBinary.Apr	164.969	92.792	1.778	7.68%		
mBinary.May	294.456	122.556	2.403	1.71%		
mBinary.Jun	267.018	129.190	2.067	3.99%		
mBinary.Jul	468.104	137.287	3.410	0.08%		
mBinary.Aug	229.448	119.272	1.924	5.57%		
mBinary.Sep	287.570	96.104	2.992	0.31%		
mBinary.Nov	297.839	77.209	3.858	0.02%		
RES_Cust.TrendVar	-10.123	2.154	-4.699	0.00%		
RES_Cust.Jun21thruMar22	-779.685	311.070	-2.506	1.29%		
RES_Cust.July2016	1265.407	313.554	4.036	0.01%		
RES_Cust.Sept2016	-806.302	314.674	-2.562	1.11%		
RES_Cust.May2018	610.713	313.823	1.946	5.30%		
RES_Cust.Dec2019	800.625	307.393	2.605	0.98%		
RES_Cust.Sept2019	-1002.139	313.859	-3.193	0.16%		
AR(1)	0.915	0.031	29.393	0.00%		

Table 14: KS Metro Small GS Commercial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	-8227.812	839.000	-9.807	0.00%		Constant term
ResCustomers.RES_Cust	0.121	0.008	15.079	0.00%		
Economics.GP_Non_Man	0.047	0.011	4.252	0.00%	N/A	
SML_Cust.July16	-1151.517	106.815	-10.780	0.00%		
SML_Cust.Aug11	480.843	106.011	4.536	0.00%		
SML_Cust.Mar14	387.346	106.023	3.653	0.03%		
SML_Cust.Sept16	248.502	106.683	2.329	2.08%		
SML_Cust.Feb13	-375.849	105.993	-3.546	0.05%		
AR(1)	0.699	0.053	13.207	0.00%		

Table 15: KS Metro Big GS Commercial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
mEcon.Population_log	678.542	3.422	198.270	0.00%		
BIG_Cust.Jul08	64.658	33.974	1.903	5.86%		
BIG_Cust.Sep11	195.748	41.062	4.767	0.00%		
BIG_Cust.Oct11	410.144	47.119	8.704	0.00%		
BIG_Cust.Nov11	89.142	41.045	2.172	3.11%		
BIG_Cust.Mar13	113.676	33.922	3.351	0.10%		
BIG_Cust.Apr17	189.223	33.899	5.582	0.00%		
BIG_Cust.Calib	-44.809	29.896	-1.499	13.56%		
BIG_Cust.Aug17	-121.821	33.932	-3.590	0.04%		
BIG_Cust.Feb12	112.286	33.899	3.312	0.11%		
AR(1)	0.816	0.042	19.325	0.00%		

Table 16: KS Metro Industrial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	0.887	1.970	0.450	65.30%		Constant term
IND_Cust.LagDep(1)	0.998	0.002	480.375	0.00%		
IND_Cust.Sep08	19.418	5.981	3.247	0.14%		
MA(1)	-0.862	0.036	-24.119	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[25]

4.1 Significant Energy and/or Peak Demand use for each Major Class[26]

4.1.1 End-Use Load Information[27]

Residential Sector[28]

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.

Commercial Sector[29]

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

[25] 20 CSR 4240-22.030(4)
[26] 20 CSR 4240-22.030(4)(A)
[27] 20 CSR 4240-22.030(4)(A)(1)
[28] 20 CSR 4240-22.030(4)(A)(1)(A)
[29] 20 CSR 4240-22.030(4)(A)(1)(B)

provided to Evergy Metro by Itron Inc. through the Energy Forecasting Group (EFG). The spreadsheets are documented in *2023_CommercialSAE.pdf*. These files are provided in the workpapers.

Industrial Sector[30]

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[31]

Removal or Consolidation of End-Use Loads[32]

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

Additions to End-Use Loads[33]

In 2011 Evergy Metro added electric vehicles (including PHEVs) to our database. In the 2023 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. Starting with the base year 2022 forecast, we used the EIA forecast estimate combined with Evergy territory solar adoptions to produce a standalone solar forecast for Residential and Commercial.

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[30] 20 CSR 4240-22.030(4)(A)(1)(C)
[31] 20 CSR 4240-22.030(4)(A)(2)
[32] 20 CSR 4240-22.030(4)(A)(2)(A)
[33] 20 CSR 4240-22.030(4)(A)(2)(B)

Modification of End-Use Documentation[34]

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[35]

Evergy Metro completed a DSM potential study in 2022. 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 the stakeholders' group.

4.1.4 Weather Effects on Load[36]

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

[34] 20 CSR 4240-22.030(4)(A)(2)(C)
[35] 20 CSR 4240-22.030(4)(A)(3)
[36] 20 CSR 4240-22.030(4)(A)(4)

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 2020-2023 load research data.

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

4.2 End-Use Development[37]

4.2.1 Measures of The Stock of Energy-Using Capital Goods[38]

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 2022 in conjunction with the 2022 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 conducted 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

[37] 20 CSR 4240-22.030(4)(B)
[38] 20 CSR 4240-22.030(4)(B)(1)

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[39]

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 applied to each class and end-

[39] 20 CSR 4240-22.030(4)(B)(2)

use. This process is done for Missouri and Kansas and completed in an Excel worksheet provided in the workpapers.

Section 5: Selecting Load Forecasting Models[40]

5.1 Consumption Drivers and Usage Patterns[41]

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 responsible for constructing and maintaining energy demand models and 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.

[40] 20 CSR 4240-22.030(5)
[41] 20 CSR 4240-22.030(5)(A)

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[42]

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 2023 (AEO2023) differed from the AEO2020 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
- End-use energy intensity projections
- End-use efficiency projections
- Impact of the federal efficiency investment tax incentives associated with the Inflation Reduction Act.

Total Residential intensity follows a growth trajectory very similar to the 2012 Annual Energy Outlook over the 20-year period 2023-2043, with both at -01%. A slightly sharper decline in Cooling intensity is offset by stronger growth in Base Miscellaneous consumption.

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

- End-use energy intensity projections

[42] 20 CSR 4240-22.030(5)(B)

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

There was a slight increase in trajectory for total Commercial intensity in the 2023 outlook compared to the 2022 outlook, increasing -0.5% to -0.7%. This change is primarily due to ventilation and lighting end-uses.

5.3 Policy Analysis[43]

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	

[43] 20 CSR 4240-22.030(5)(C)

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

Commercial/Industrial								
Product Covered	Initial Legislati	Last Standa	Compliance D	Issued By	Proposed S	New Final S	Potential Com	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[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
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[44]

6.1 Description and Documentation[45]

6.1.1 Determination of Independent Variables[46]

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 describe 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 end-uses: heating, cooling and other, and these were then calibrated to monthly billed sales per customer in a linear regression. This is described in *Appendix 3: Residential SAE Modeling Framework* in the file *Res2023SAEUpdate.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

44 20 CSR 4240-22.030(6)
45 20 CSR 4240-22.030(6)(A)
46 20 CSR 4240-22.030(6)(A)(1)

three major end-uses: 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 3: Commercial Statistically Adjusted End-Use Model* in the file *2023CommercialSAE.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 3: Commercial Statistically Adjusted End-Use Model* in the file *2023CommercialSAE.pdf*.

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.[47]

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 fourth 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 2023 and a June 2023 vintage economic forecast of the KC metro area from Moody's Analytics.[48]

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[47] 20 CSR 4240-22.030(6)(A)(1)(A)
[48] 20 CSR 4240-22.030(6)(A)(1)(B)

6.1.2 Development of Mathematical & Statistical Equations Comprising the Load Forecast Models[49]

Table 20: MO Metro Residential kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value
mStrucVars.XHeat55_RES	0.682	0.009	72.907	0.00%
mStrucVars.XCool65_RES	0.790	0.008	96.713	0.00%
mStrucVars.XOther_RES	1.138	0.011	100.431	0.00%
RES_AvgUse.Yr09	-12.289	6.908	-1.779	7.73%
RES_AvgUse.Nov09	77.095	22.858	3.373	0.10%
RES_AvgUse.Aug10	-33.314	22.178	-1.502	13.52%
RES_AvgUse.Feb11	-56.865	21.699	-2.621	0.97%
RES_AvgUse.Jul12	-38.903	22.325	-1.743	8.35%
RES_AvgUse.Feb15	-54.853	21.462	-2.556	1.16%
RES_AvgUse.Sep20	62.884	21.792	2.886	0.45%
RES_AvgUse.Dec20	-45.844	21.918	-2.092	3.82%
mBinary.Mar	15.381	5.975	2.574	1.10%
mBinary.Jun	-53.704	6.138	-8.750	0.00%
mBinary.Aug	29.636	7.423	3.992	0.01%
mBinary.Nov	-28.364	6.569	-4.318	0.00%
tGooogleMobility.MO_Residence_Cyc	-0.623	0.869	-0.716	47.49%
RES_AvgUse.CalibCCB	-31.408	7.791	-4.031	0.01%
RES_AvgUse.Calib	-2.763	4.275	-0.646	51.90%
RES_AvgUse.Calib2	-17.208	5.577	-3.086	0.24%
RES_AvgUse.May21toAug21	-100.300	11.264	-8.905	0.00%
RES_AvgUse.Dec21	-42.269	21.466	-1.969	5.08%
RES_AvgUse.May22	-54.203	21.399	-2.533	1.23%
RES_AvgUse.Jan2023	104.955	21.410	4.902	0.00%
RES_AvgUse.Expr1	-67.205	15.716	-4.276	0.00%

[49] 20 CSR 4240-22.030(6)(A)(2)

Table 21: MO Metro Small GS Commercial kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_SML	1.283	0.081	15.940	0.00%	kWh
mStrucVars.XCool60_SML	0.820	0.038	21.786	0.00%	Kwh
mStrucVars.XOther_SML	0.869	0.208	4.179	0.01%	kWh
SML_AvgUse.Expr1	-214.163	52.432	-4.085	0.01%	
SML_AvgUse.Expr2	221.449	53.315	4.154	0.01%	
AR(1)	1.003	0.014	69.230	0.00%	

Table 22: MO Metro Big GS Commercial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_BIG	409.732	21.460	19.092	0.00%	kWh
mStrucVars.XCool60_BIG	444.553	9.312	47.741	0.00%	Kwh
mStrucVars.XOther_BIG	523.329	30.352	17.242	0.00%	kWh
BIG_Sales.Sep11	19313624.837	6934958.939	2.785	0.60%	
BIG_Sales.Jan15	13801391.800	7072642.768	1.951	5.27%	
BIG_Sales.Feb19	18646550.776	7085924.495	2.631	0.93%	
BIG_Sales.Jul19	-19209423.480	7069767.887	-2.717	0.73%	
mBinary.Oct	8866627.946	2063301.931	4.297	0.00%	
mBinary.Nov	-7844308.745	2077076.396	-3.777	0.02%	
BIG_Sales.CalibBIG	4864928.198	1640668.893	2.965	0.35%	
BIG_Sales.CalibBigTrend	3696.998	150.492	24.566	0.00%	
BIG_Sales.BeforeMay18	9874026.081	1697223.115	5.818	0.00%	
tGoogleMobility.MO_Workplace_Cyc	1251072.697	91353.100	13.695	0.00%	
BIG_Sales.Mar21	23826358.686	6987059.159	3.410	0.08%	
BIG_Sales.Feb21	13321337.213	7106769.995	1.874	6.26%	
mBinary.Jun	-6889059.994	1954680.451	-3.524	0.06%	

Table 23: MO Metro Industrial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value
mStrucVars.XCool60_IND	12798.654	1018.134	12.571	0.00%
mStrucVars.XOther_IND	11733.571	1623.022	7.229	0.00%
mBinary.Mar	3592200.116	1152939.104	3.116	0.22%
mBinary.Aug	5994637.306	1306941.139	4.587	0.00%
IND_Sales.PrevCalib	1828.214	144.034	12.693	0.00%
IND_Sales.AutoCalib	81.639	31.059	2.629	0.94%
IND_Sales.CalibCCB	2331779.241	1118641.438	2.084	3.88%
tGoogleMobility.MO_AvgWorkRec	454912.825	90822.714	5.009	0.00%
IND_Sales.Nov12	-13006901.208	4250932.186	-3.060	0.26%
IND_Sales.Jun13toJun14	4831690.898	1581260.905	3.056	0.27%
IND_Sales.Jul15	10939048.983	4324933.387	2.529	1.24%
IND_Sales.Nov18	13214187.845	4296973.023	3.075	0.25%
IND_Sales.Jan15	-13848909.386	4353103.666	-3.181	0.18%
IND_Sales.Jul19	-21215238.976	4315189.988	-4.916	0.00%
IND_Sales.Sep19	14764258.341	4310918.171	3.425	0.08%
IND_Sales.Jun20	20591379.264	4393793.915	4.686	0.00%
IND_Sales.May21	-9493319.670	4275792.273	-2.220	2.79%
IND_Sales.Sep20	12822638.461	4299099.657	2.983	0.33%
IND_Sales.Dec20	14750547.832	4360492.022	3.383	0.09%
MA(1)	0.204	0.086	2.372	1.89%

Table 24: KS Metro Residential kWh per Customer

A	B	C	D	E	F
Variable	Coefficient	StdErr	T-Stat	P-Value	Units
RES_AvgUse.Jul11	119.483	24.678	4.842	0.00%	
RES_AvgUse.Aug12	-77.180	24.875	-3.103	0.23%	
RES_AvgUse.Jun16	56.427	25.321	2.228	2.72%	
RES_AvgUse.Jul17	47.718	25.025	1.907	5.83%	
RES_AvgUse.Sep17	75.087	24.709	3.039	0.28%	
RES_AvgUse.CalibCCB	-34.858	17.278	-2.018	4.53%	
RES_AvgUse.Jul21toAug21	-92.882	23.137	-4.014	0.01%	
RES_AvgUse.Jan2023	96.980	26.085	3.718	0.03%	
RES_AvgUse.Aug2022	-60.026	26.285	-2.284	2.37%	
AR(1)	0.439	0.082	5.364	0.00%	
SMA(1)	0.300	0.083	3.600	0.04%	

Table 25: KS Metro Small GS Commercial kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_SML	0.820	0.037	22.084	0.00%	kWh
mStrucVars.XCool60_SML	0.665	0.018	37.034	0.00%	Kwh
mStrucVars.XOther_SML	0.211	0.059	3.564	0.05%	kWh
mBinary.Dec	54.423	16.053	3.390	0.09%	
SML_AvgUse.YR11	-26.320	17.650	-1.491	13.78%	
mBinary.Oct11	-124.675	56.500	-2.207	2.87%	
mBinary.Apr12	-117.497	54.465	-2.157	3.24%	
SML_AvgUse.Mar13	-135.733	55.073	-2.465	1.47%	
mBinary.Oct13	-137.504	54.367	-2.529	1.23%	
mBinary.Jun14	-120.551	54.581	-2.209	2.85%	
SML_AvgUse.Yr15	42.200	18.465	2.285	2.35%	
SML_AvgUse.Dec16	-109.335	56.549	-1.933	5.48%	
SML_AvgUse.Jan17	145.782	55.394	2.632	0.93%	
SML_AvgUse.Apr17	-157.842	55.053	-2.867	0.47%	
SML_AvgUse.Jun17	-109.927	54.895	-2.003	4.68%	
SML_AvgUse.Feb18	131.170	55.227	2.375	1.86%	
mBinary.CalibSml	-352.826	17.823	-19.796	0.00%	
SML_AvgUse.CalibSwitch	0.026	0.001	23.677	0.00%	
SML_AvgUse.CalibCCB	-222.610	17.380	-12.808	0.00%	
SML_AvgUse.CalibCCB2	-158.542	23.471	-6.755	0.00%	
tGoogleMobility.KS_Workplace_Cyc	-3.143	0.979	-3.212	0.16%	
mBinary.CalibCov	-302.768	39.979	-7.573	0.00%	
SML_AvgUse.Jan2023	282.907	54.578	5.184	0.00%	

Table 26: KS Metro Big GS Commercial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units
mStrucVars.XHeat55_BIG	408.619	19.637	20.808	0.00%	kWh
mStrucVars.XCool60_BIG	465.110	10.606	43.854	0.00%	Kwh
mStrucVars.XOther_BIG	456.244	34.425	13.253	0.00%	kWh
mBinary.Jul	-2561279.449	1711686.535	-1.496	13.63%	
BIG_Sales.Calib	-7475605.903	1289515.302	-5.797	0.00%	
BIG_Sales.CalibTrn	3232.357	129.423	24.975	0.00%	
BIG_Sales.CalibBIG	3632178.071	1641285.923	2.213	2.81%	
BIG_Sales.YR18	8152822.362	1944504.318	4.193	0.00%	
BIG_Sales.Jun18	-19014192.603	5938106.100	-3.202	0.16%	
BIG_Sales.Sep18	-25705124.552	5935085.086	-4.331	0.00%	
BIG_Sales.FebMar19	13618216.892	4109534.260	3.314	0.11%	
tGoogleMobility.KS_Workplace_Cyc	753952.709	61568.800	12.246	0.00%	

Table 27: KS Metro Industrial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
mStrucVars.XCool_IND	4140.187	197.386	20.975	0.00%		
mStrucVars.XOther_IND	3380.049	410.504	8.234	0.00%		
IND_Sales.Nov06	0.000	0.000	0.000	100.00%		
IND_Sales.Oct08	1333267.261	503613.212	2.647	0.89%		
IND_Sales.Jan09	-1521578.896	507413.804	-2.999	0.31%		
mBinary.Feb10	4079694.783	520377.357	7.840	0.00%		
mBinary.Jun10	-1669899.357	505639.904	-3.303	0.12%		
mBinary.Aug10	1431708.446	509213.470	2.812	0.55%		
IND_Sales.Oct13	1733852.154	503681.852	3.442	0.07%		
IND_Sales.TrendBefYr14	-12.892	17.342	-0.743	45.83%		
IND_Sales.BeforeMay18	2734251.697	1025604.940	2.666	0.84%		
IND_Sales.May18	652490.329	722352.107	0.903	36.77%		
IND_Sales.Aug18	1843625.639	505051.760	3.650	0.04%		
IND_Sales.Jan21	-1396913.356	519078.753	-2.691	0.78%		
mBinary.Feb	753915.898	138486.050	5.444	0.00%		
mBinary.CalibCov	-479925.019	566580.312	-0.847	39.82%		
IND_Sales.Apr2023	3048213.181	503270.380	6.057	0.00%		
IND_Sales.Trend2022and2023	-17.427	16.049	-1.086	27.91%		
AR(1)	0.995	0.006	155.237	0.00%		

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 are 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.[iii] 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.[50]

6.2 Documentation of Deviations in Load Forecast Models[51]

There are no deviations in the independent variables or functional forms of the equations from those derived from load analysis in sections (3) and (4).

6.3 Development and Documentation of Load Forecasting Historical Database[52]

6.3.1 Historical Data Collection and Maintenance for Accurate Forecasting[53]

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 for 10 years or more; as in the case of economic data, these historical estimates are subject to revision and are updated each time Evergy Missouri West 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.

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[50] 20 CSR 4240-22.030(6)(A)(3)
[51] 20 CSR 4240-22.030(6)(B)
[52] 20 CSR 4240-22.030(6)(C)
[53] 20 CSR 4240-22.030(6)(C)(1)

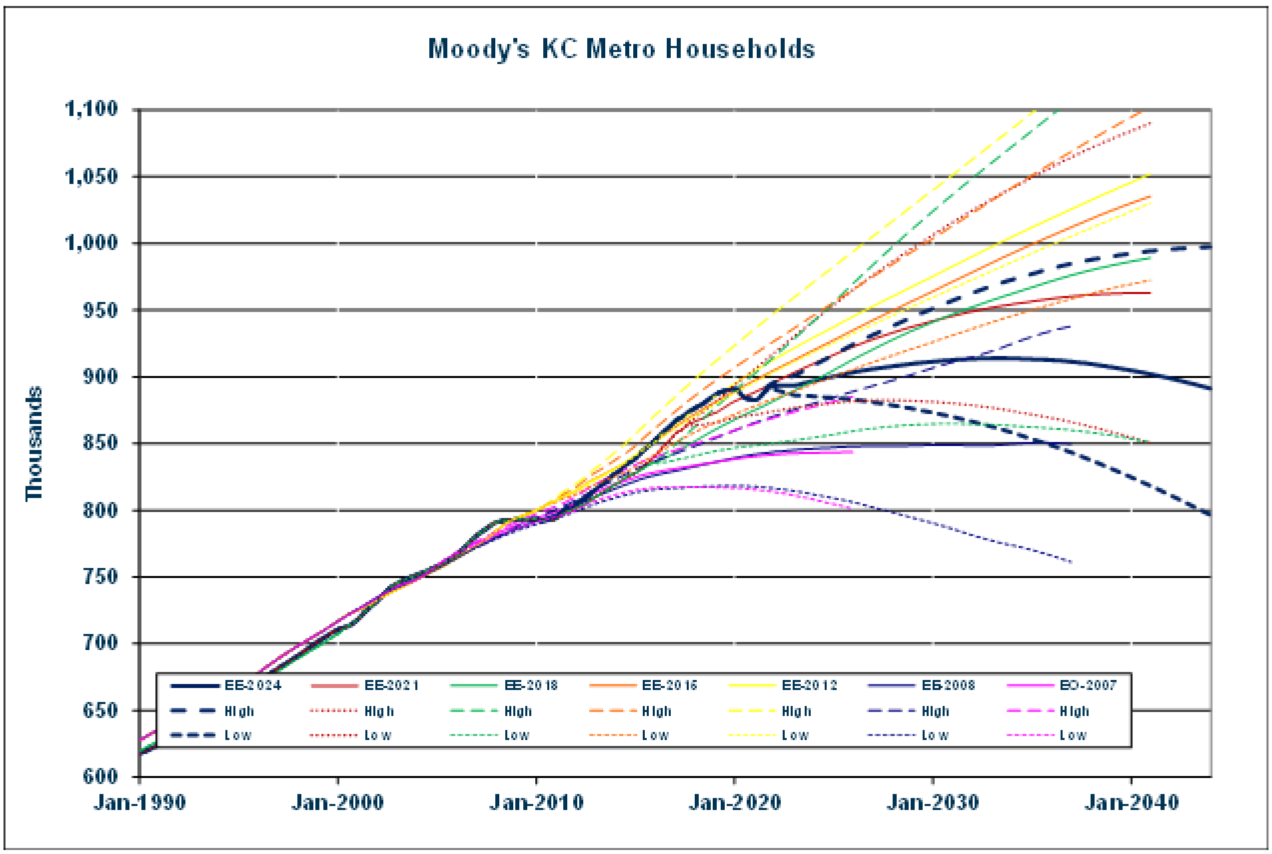
6.3.2 Independent Variable Adjustments[54]

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

6.3.3 Comparison of Historical Projected and Actual Energy Usage and Peak Load Forecasts, Including the Independent Data Sets Used to Produce the Forecasts[55]

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.

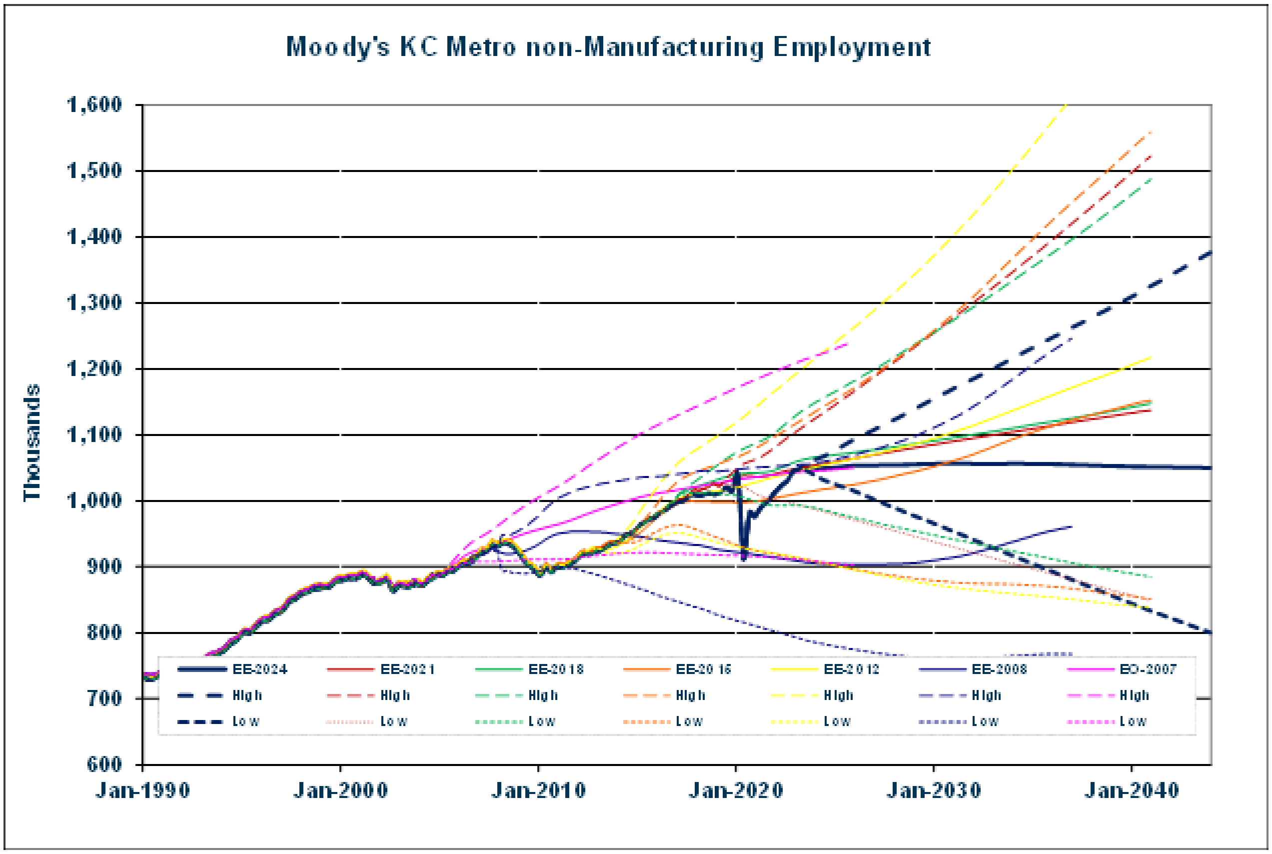
Figure 23: Households



54 20 CSR 4240-22.030(6)(C)(2)
55 20 CSR 4240-22.030(6)(C)(3)

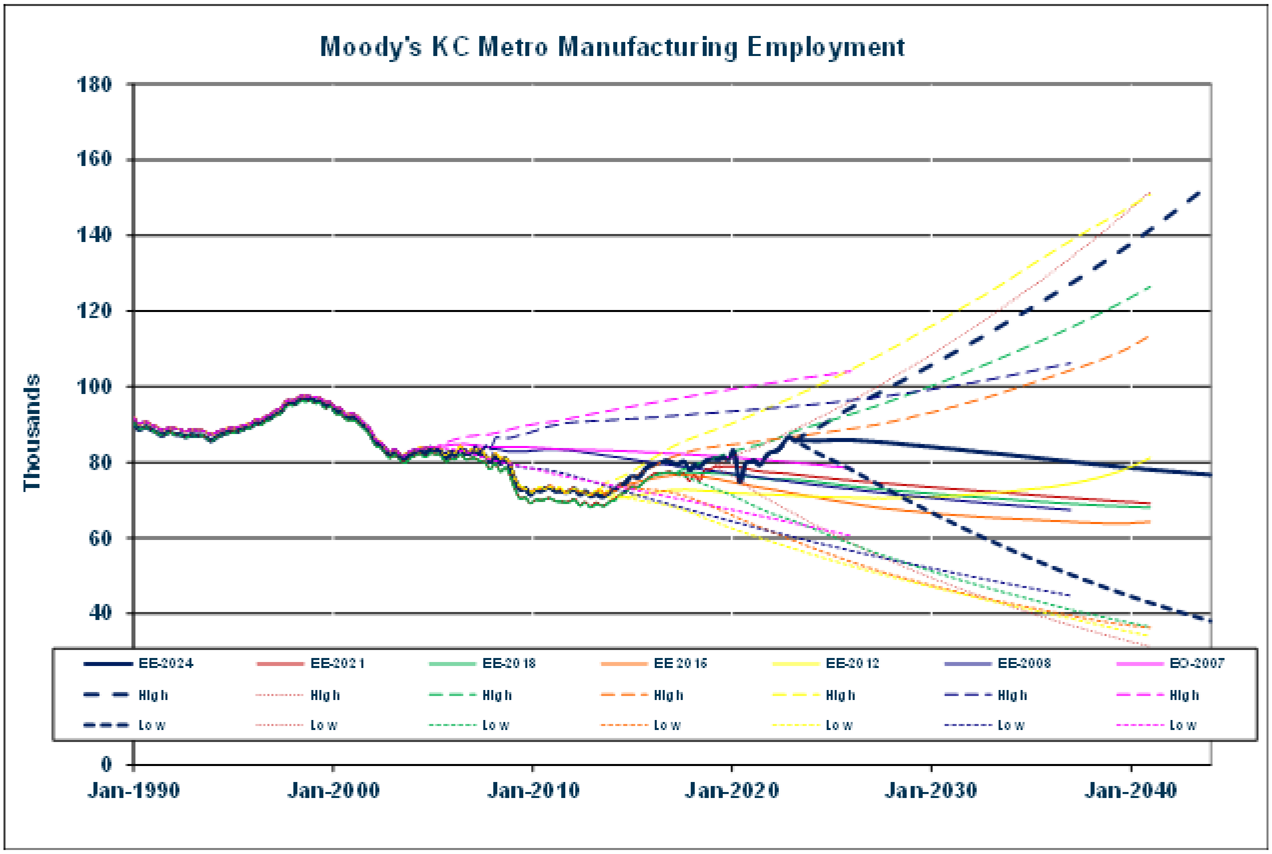
The current forecast for households has a slower long-term growth rate than the prior forecast after recent years has been higher than the last forecast.

Figure 24: Employment Non-Manufacturing



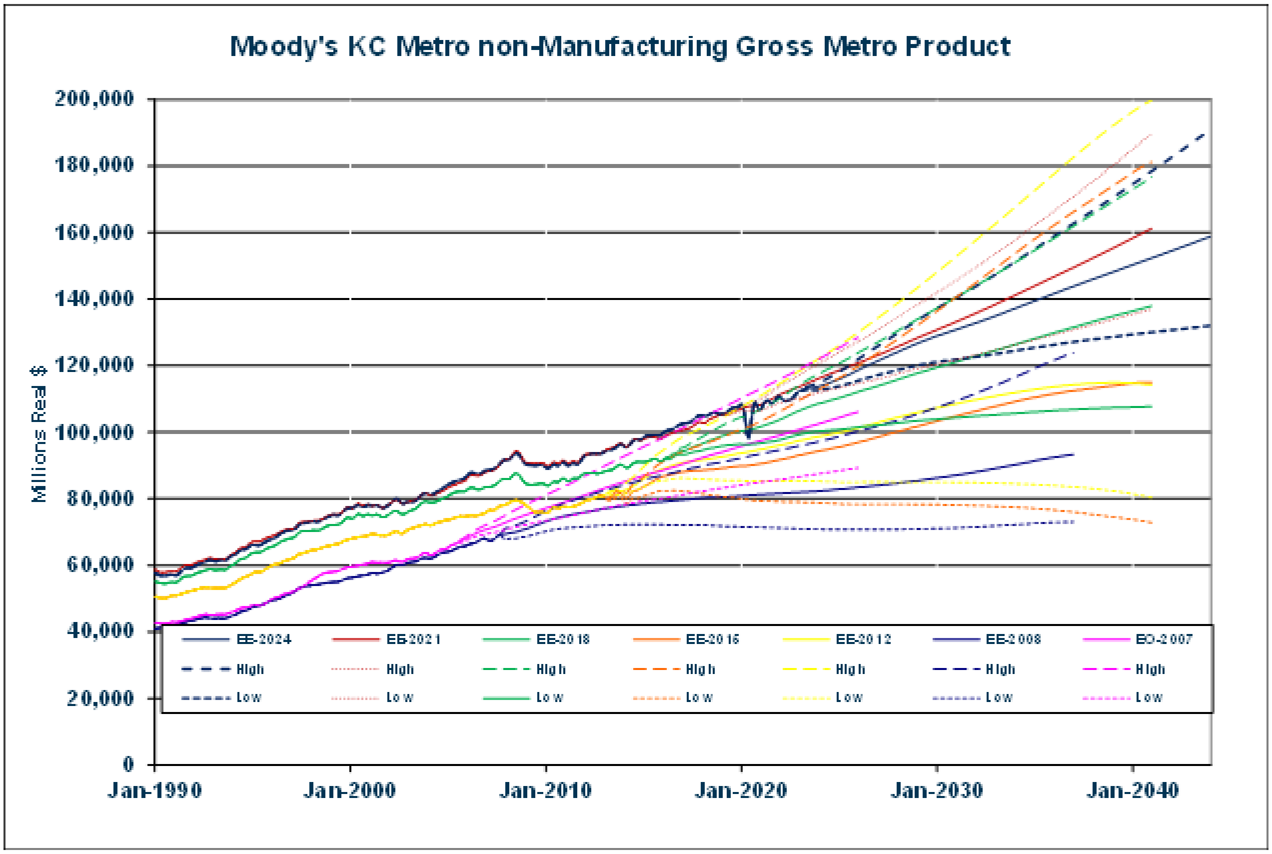
The 2024 forecast of non-manufacturing employment shows growth very similar to the 2021 forecast.

Figure 25: Employment Manufacturing



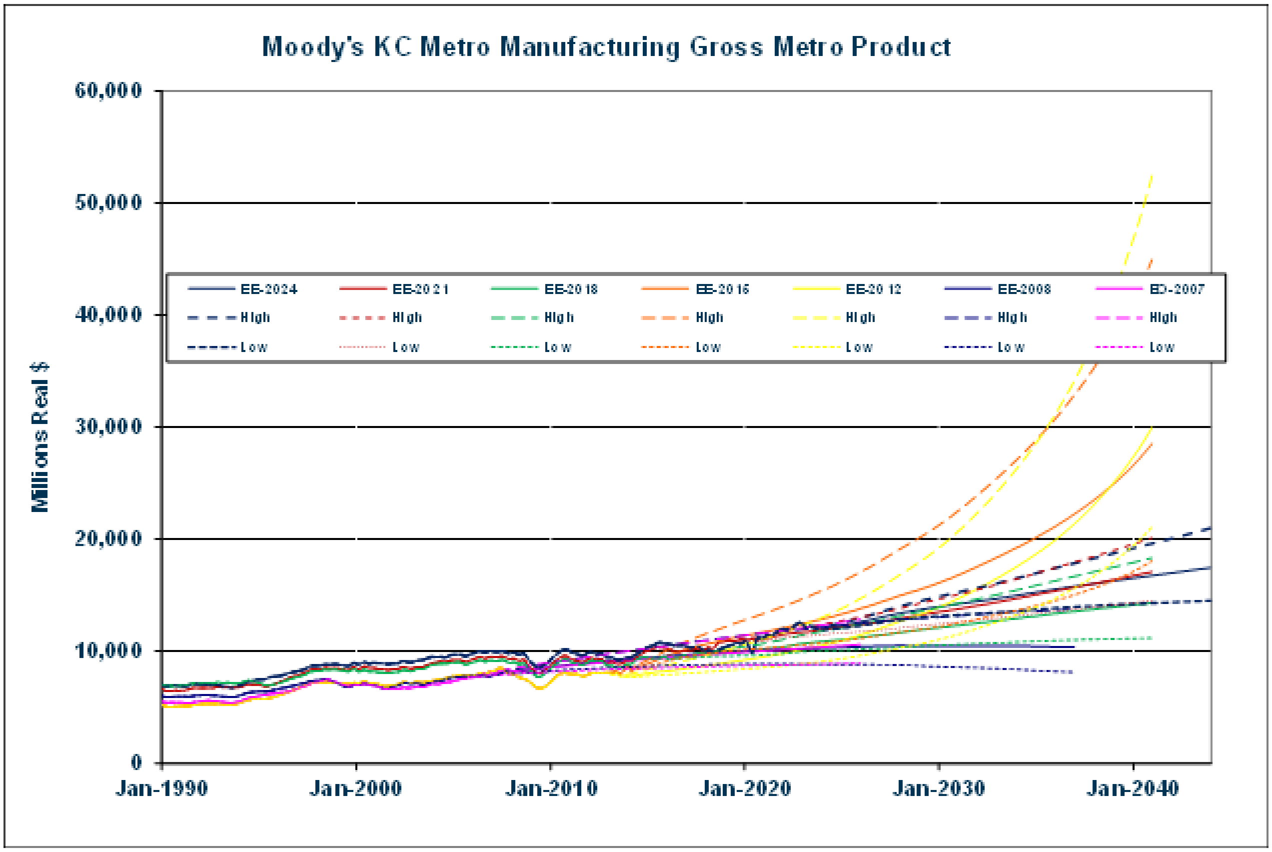
Manufacturing employment shows a large decline following the 2008 recession. It has climbed from a 2013 low and is projected to slowly decline throughout the forecast period very similar to the 2018 and 2021 forecast despite the last couple years being slightly higher than forecasted. Moody's indicates 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 the forecast. The current forecasted growth trajectory is slightly lower than previously forecasted.

Figure 27: Gross Metro Product Manufacturing

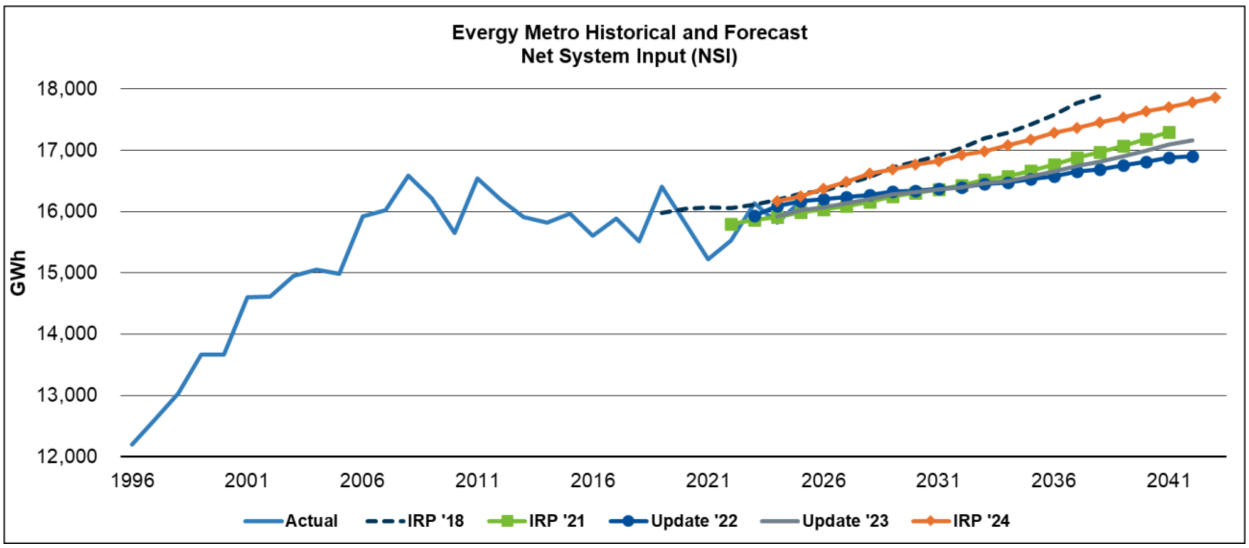


The current forecast for Manufacturing Gross Metro Product shows slow growth throughout the forecast period, though slightly faster than the 2018 forecast. Some previous Economic forecasts showed rapid growth for two reasons: (1) growth in manufacturing employment in the long run and (2) a competitive 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.

6.3.4 Comparison of Final Forecasts to Actual Energy and Peak Demand and the Current Forecast[56]

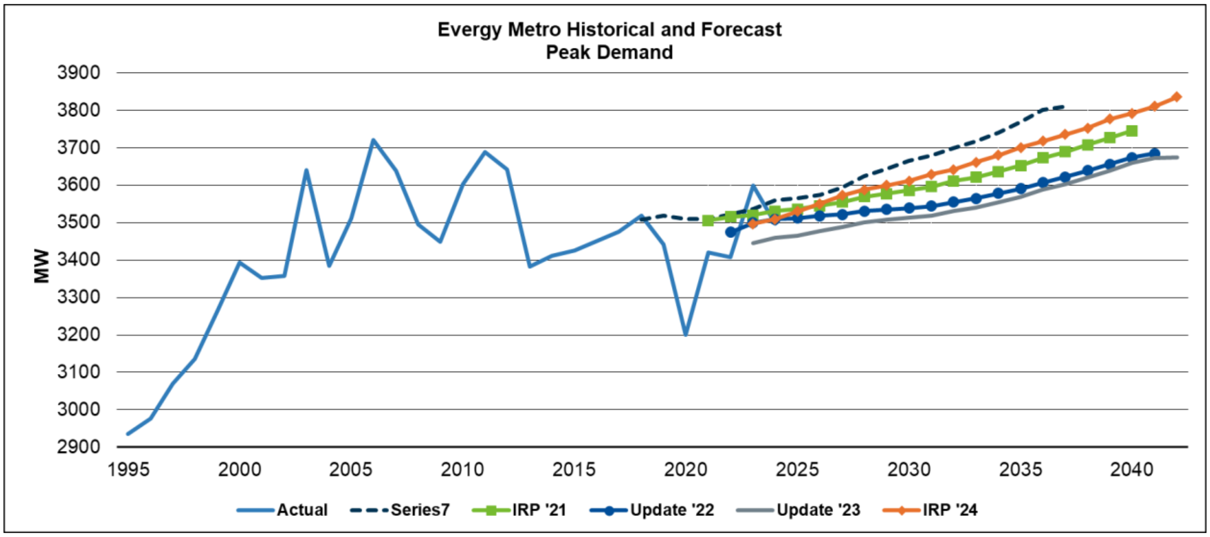
Evergy Metro maintains an archive of the electronic files associated with our previous forecasts of energy use and peak demand for at least the last ten years. The graphs below compare our previous long-run forecasts for NSI and peak demand. The most recent forecast is very similar to the prior four 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



[56] 20 CSR 4240-22.030(6)(C)(4)

Figure 29: Peak Demand Historical and Forecasts



Section 7: Base-Case Load Forecast[57]

Evergy Metro's base-case forecast was produced with a base-case economic forecast from Moody's Analytics obtained in June 2023. 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[58]

7.1.1 Describe and Document Relevant Economic and Demographics[59]

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 -0.26 (elasticities vary by customer class and end use) 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 0.3 for heating and cooling and 0.3 for other uses and a person's-per-household elasticity of 0.3. Moody's forecast of households for the KC metro area was used in the models of residential customers as was described previously in the section for rule 3.B.

[57] 20 CSR 4240-22.030(7)
[58] 20 CSR 4240-22.030(7)(A)
[59] 20 CSR 4240-22.030(7)(A)(1)

7.1.2 Describe and Document Effects of Legal Mandates[60]

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.[iv]

7.1.3 Describe and Document Consistency[61]

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[62]

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.

[60] 20 CSR 4240-22.030(7)(A)(2)
[61] 20 CSR 4240-22.030(7)(A)(3)
[62] 20 CSR 4240-22.030(7)(A)(4)

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

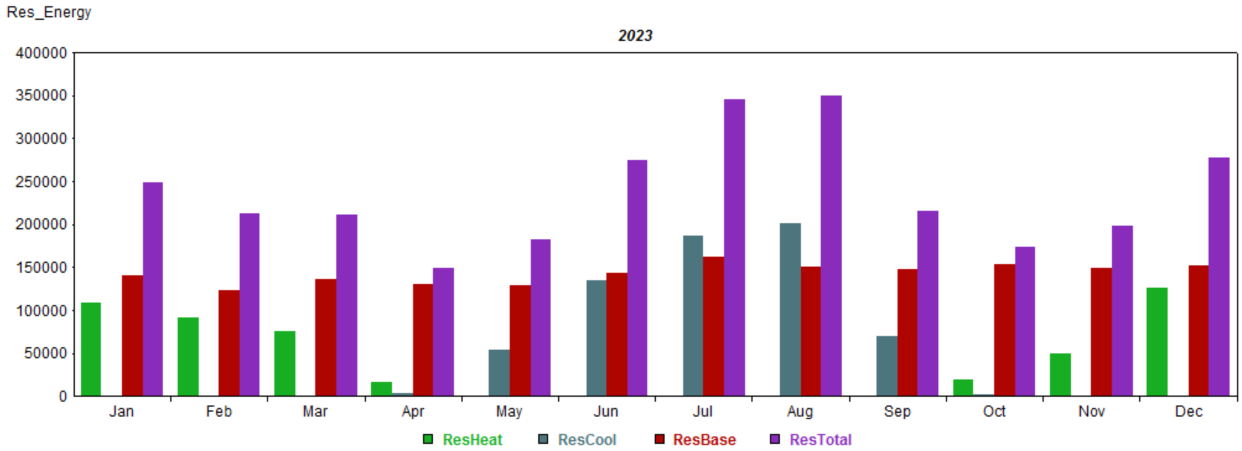


Table 28: Data Table of MO Metro Residential Monthly Cooling, Heating, and Base

Date	ResHeat	ResCool	ResBase	ResTotal
Jan-23	108,225	0	140,091	248,200
Feb-23	91,166	0	122,526	212,959
Mar-23	76,202	0	135,998	210,791
Apr-23	17,002	3,408	130,387	148,758
May-23	991	54,493	128,773	181,948
Jun-23	0	134,373	142,798	274,700
Jul-23	0	186,416	161,652	345,456
Aug-23	0	201,832	150,066	349,824
Sep-23	0	69,423	147,581	215,242
Oct-23	19,472	2,159	152,848	173,255
Nov-23	49,086	0	149,573	198,443
Dec-23	126,615	0	151,326	278,218

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

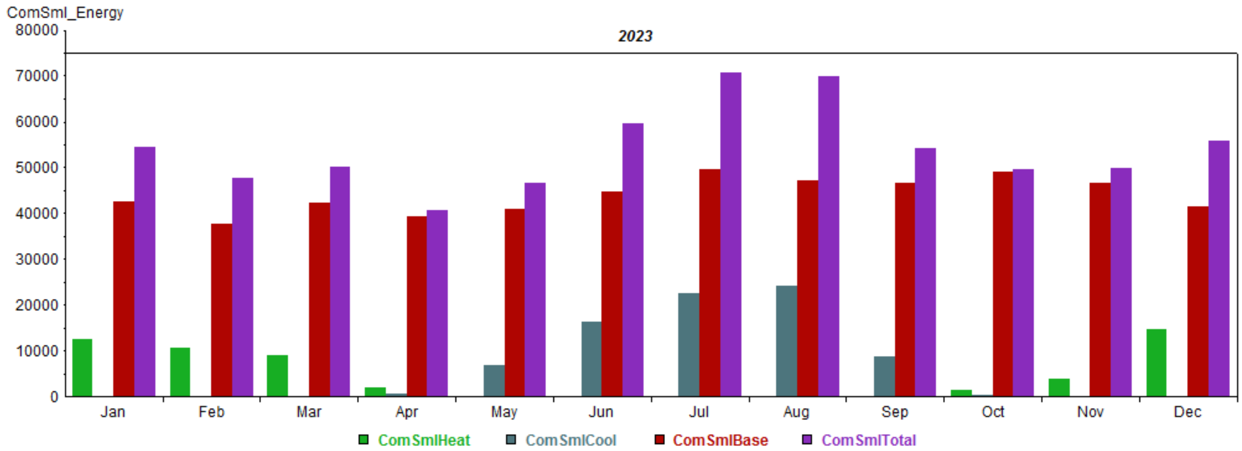


Table 29: Data Table of MO Metro Commercial Small General Service Monthly Cooling, Heating, and Base

Date	ComSmlHeat	ComSmlCool	ComSmlBase	ComSmlTotal
Jan-23	12,597	0	42,551	54,589
Feb-23	10,731	0	37,598	47,622
Mar-23	8,938	0	42,314	50,239
Apr-23	1,974	598	39,387	40,705
May-23	125	6,838	41,030	46,639
Jun-23	0	16,263	44,619	59,479
Jul-23	0	22,563	49,690	70,741
Aug-23	0	24,053	47,139	69,929
Sep-23	0	8,892	46,587	54,256
Oct-23	1,512	274	49,008	49,720
Nov-23	3,975	0	46,650	49,958
Dec-23	14,796	0	41,516	55,865

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

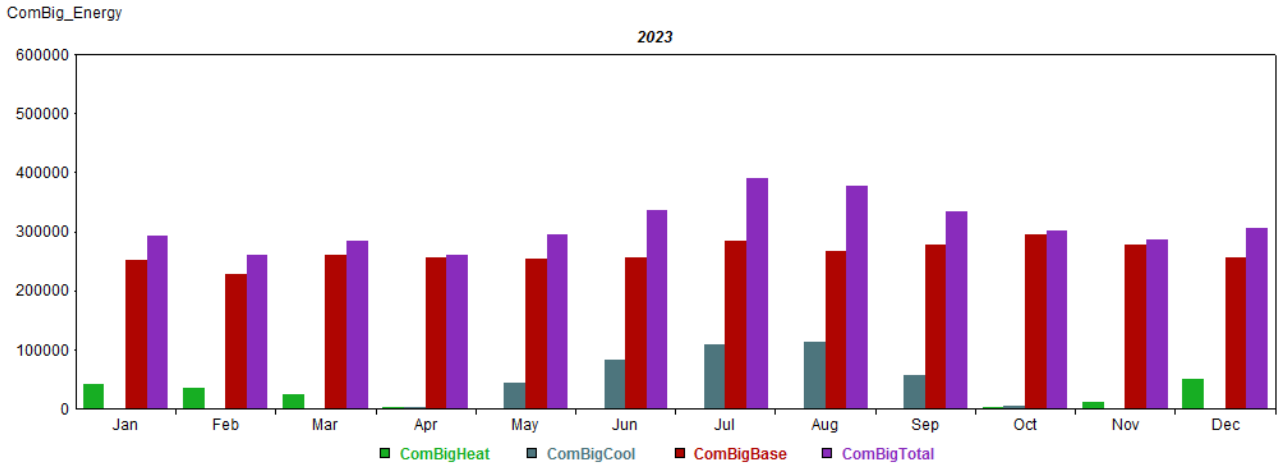


Table 30: Data Table of MO Metro Commercial Big (MGS, LGS & LP) Monthly Cooling, Heating, and Base

Date	ComBigHeat	ComBigCool	ComBigBase	ComBigTotal
Jan-23	40,761	0	252,536	292,196
Feb-23	34,431	0	227,422	260,309
Mar-23	25,504	0	260,866	284,044
Apr-23	3,454	3,275	257,152	260,894
May-23	0	44,078	254,099	294,911
Jun-23	0	83,717	256,577	336,887
Jul-23	0	110,166	284,585	391,109
Aug-23	0	113,606	267,009	377,620
Sep-23	0	57,718	278,579	333,454
Oct-23	3,450	4,406	295,725	301,193
Nov-23	10,684	0	276,924	286,269
Dec-23	49,919	0	256,637	305,760

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

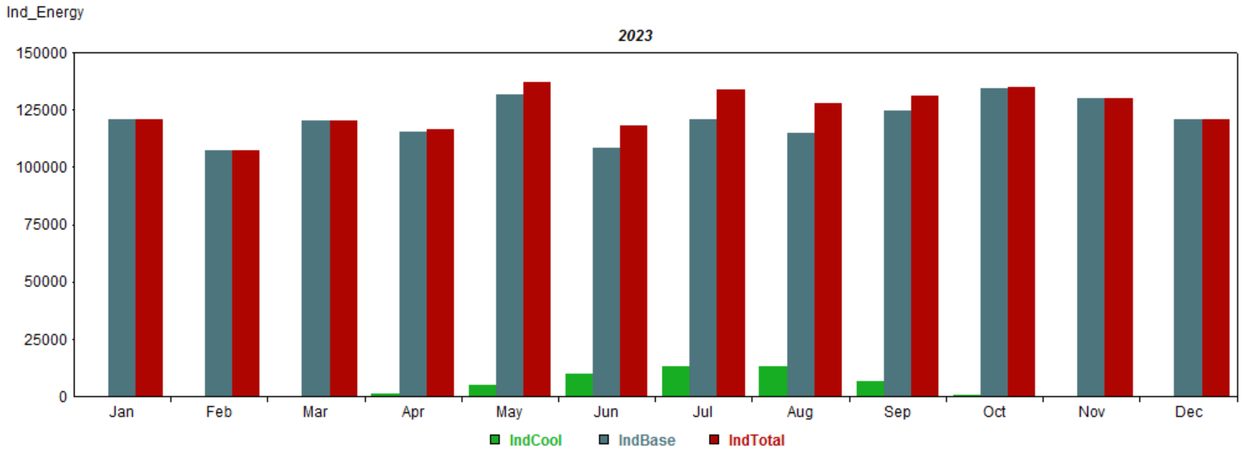


Table 31: Data Table of MO Metro Industrial Monthly Cooling, Heating, and Base

Date	IndCool	IndBase	IndTotal
Jan-23	0	120,844	120,844
Feb-23	0	107,146	107,146
Mar-23	0	120,246	120,246
Apr-23	1,054	115,254	116,308
May-23	5,267	131,770	137,036
Jun-23	9,925	108,274	118,199
Jul-23	12,996	120,992	133,988
Aug-23	13,409	114,644	128,053
Sep-23	6,864	124,446	131,310
Oct-23	537	134,278	134,815
Nov-23	0	130,037	130,037
Dec-23	0	121,036	121,036

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

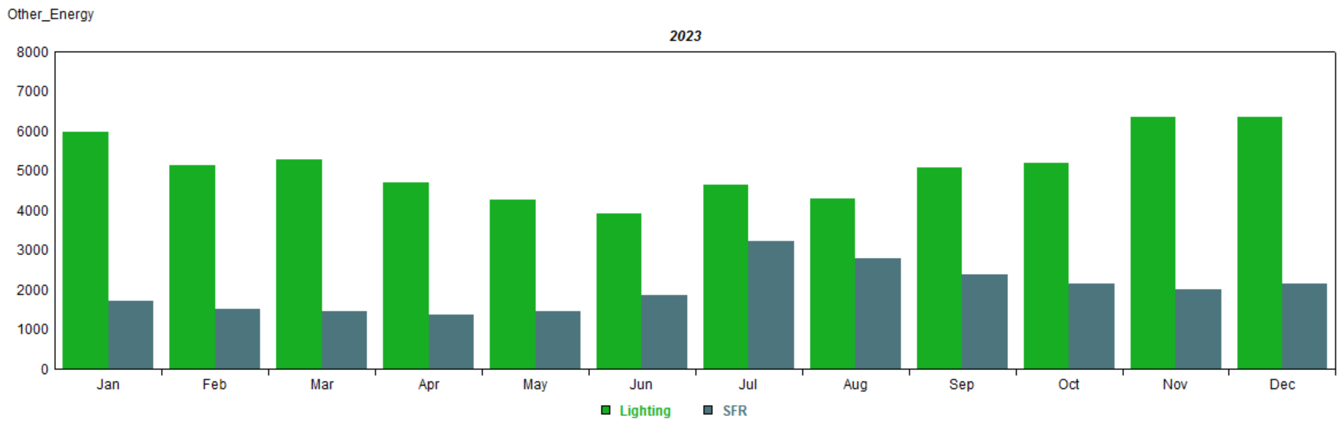


Table 32: Data Table Other MO Metro Load (SFR & Lighting)

Date	Lighting	SFR
Jan-23	5,964	1,707
Feb-23	5,140	1,522
Mar-23	5,285	1,461
Apr-23	4,702	1,381
May-23	4,256	1,461
Jun-23	3,924	1,855
Jul-23	4,633	3,239
Aug-23	4,310	2,808
Sep-23	5,076	2,379
Oct-23	5,186	2,153
Nov-23	6,340	2,021
Dec-23	6,356	2,150

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

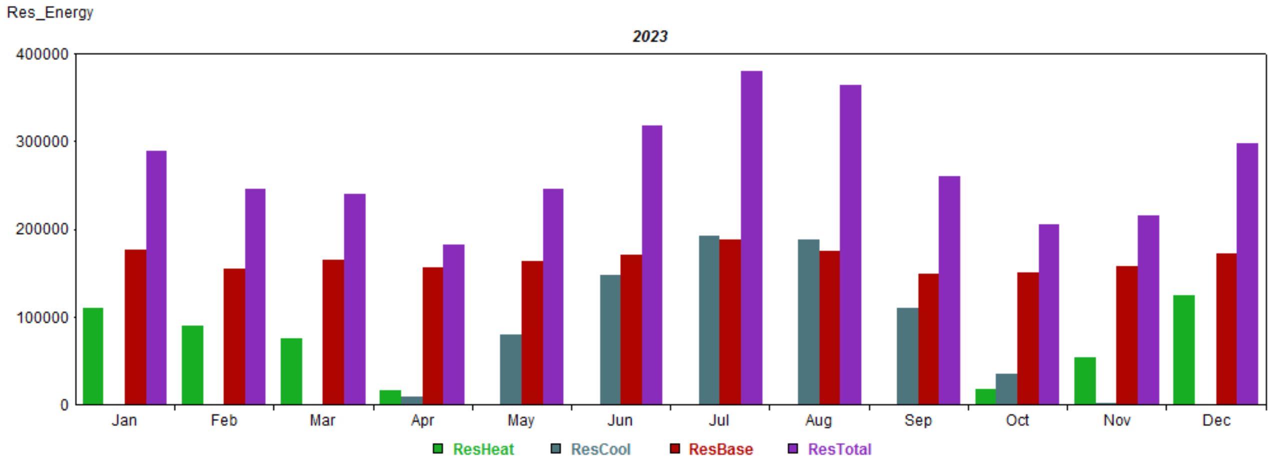


Table 33: Data Table of KS Metro Residential Monthly Cooling, Heating, and Base

Date	ResHeat	ResCool	ResBase	ResTotal
Jan-23	110,422	0	176,898	288,842
Feb-23	89,689	0	154,523	245,206
Mar-23	75,130	0	164,485	240,472
Apr-23	16,024	9,385	156,363	182,322
May-23	916	80,105	163,881	245,301
Jun-23	0	147,241	170,619	318,078
Jul-23	0	192,250	187,982	380,604
Aug-23	0	188,224	174,927	363,638
Sep-23	0	109,436	149,674	259,862
Oct-23	18,090	35,645	150,883	205,725
Nov-23	53,520	2,511	157,414	214,929
Dec-23	124,754	0	171,771	298,102

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

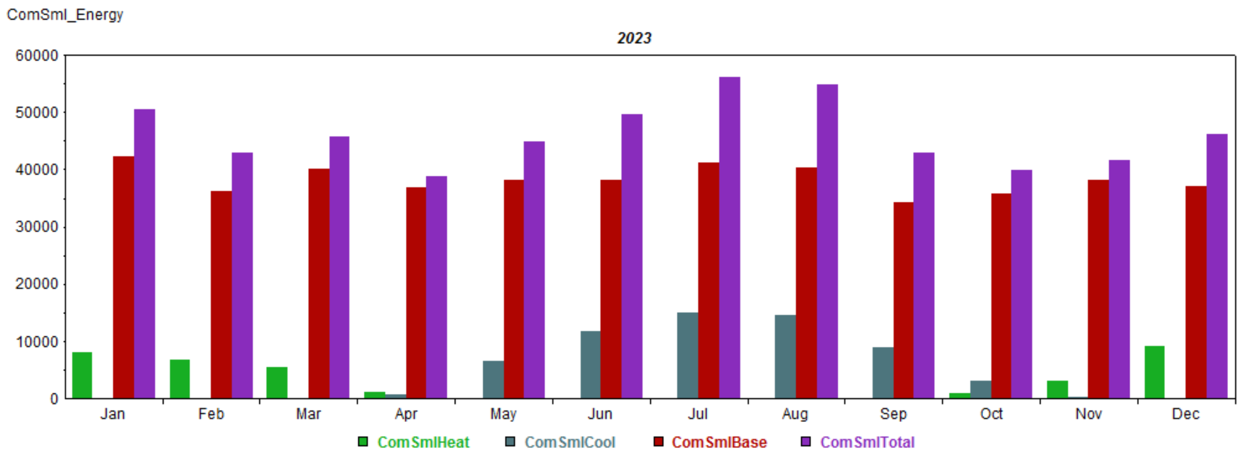


Table 34: Data Table of KS Metro Commercial Small General Service Monthly Cooling, Heating, and Base

Date	ComSmlHeat	ComSmlCool	ComSmlB	ComSmlTotal
Jan-23	8,129	0	42,383	50,537
Feb-23	6,703	0	36,165	42,854
Mar-23	5,579	0	40,160	45,689
Apr-23	1,181	668	36,943	38,702
May-23	74	6,641	38,214	44,816
Jun-23	0	11,669	38,094	49,648
Jul-23	0	14,929	41,225	56,033
Aug-23	0	14,464	40,383	54,753
Sep-23	0	8,860	34,176	42,974
Oct-23	1,016	3,038	35,768	39,800
Nov-23	3,224	213	38,256	41,712
Dec-23	9,231	0	36,989	46,259

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

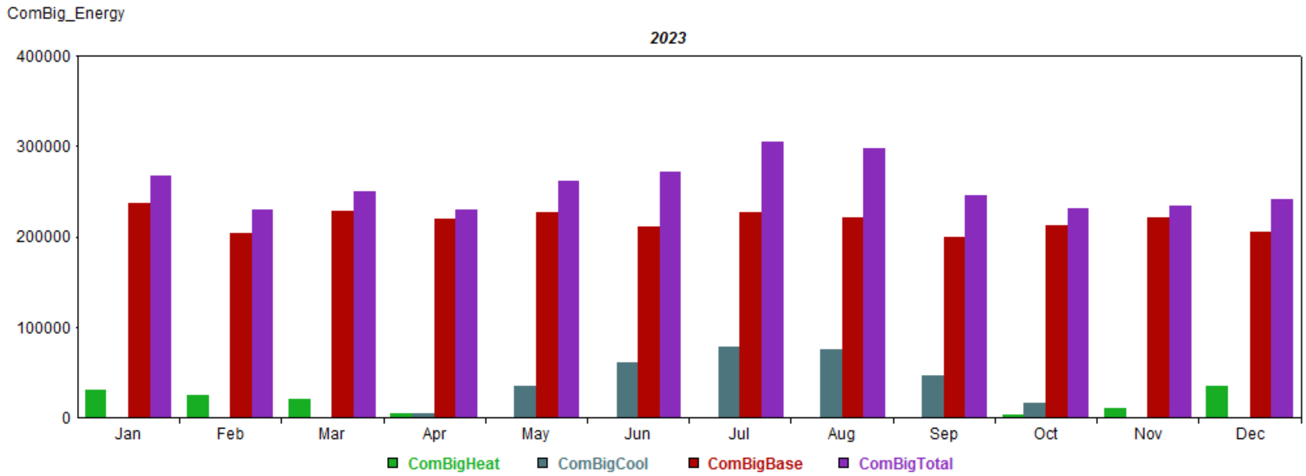


Table 35: Data Table of KS Metro Commercial Big General Service (MGS and LGS) Monthly Cooling, Heating, and Base

Date	ComBigHeat	ComBigCool	ComBigBa	ComBigTotal
Jan-23	31,014	0	236,634	268,072
Feb-23	25,459	0	204,187	229,859
Mar-23	21,232	0	228,846	250,165
Apr-23	4,498	5,165	219,699	229,269
May-23	274	35,316	226,797	262,206
Jun-23	0	61,715	210,728	272,220
Jul-23	0	78,407	226,749	304,934
Aug-23	0	75,877	221,775	297,537
Sep-23	0	46,326	198,834	245,178
Oct-23	3,429	15,865	212,301	231,816
Nov-23	11,110	1,130	221,963	234,600
Dec-23	35,156	0	205,816	241,429

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

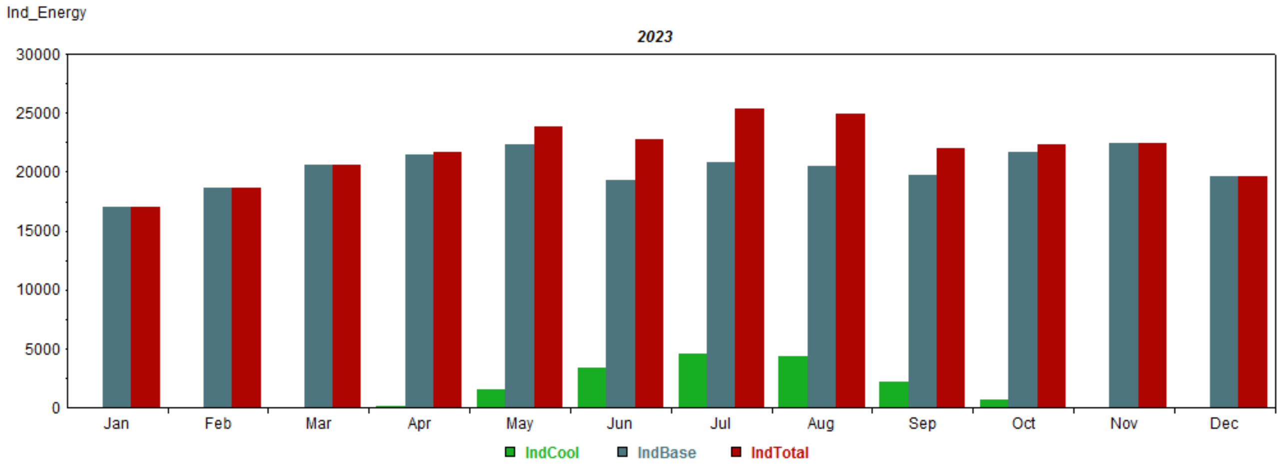


Table 36: Data Table of KS Metro Industrial Monthly Cooling, Heating, and Base

Date	IndCool	IndBase	IndTotal
Jan-23	-	16,988	16,988
Feb-23	-	18,599	18,599
Mar-23	-	20,621	20,621
Apr-23	131	21,515	21,646
May-23	1,583	22,303	23,886
Jun-23	3,448	19,288	22,736
Jul-23	4,545	20,858	25,403
Aug-23	4,377	20,502	24,879
Sep-23	2,240	19,754	21,994
Oct-23	655	21,684	22,339
Nov-23	-	22,467	22,467
Dec-23	-	19,628	19,628

Figure 39: Other KS Metro Load (Lighting)

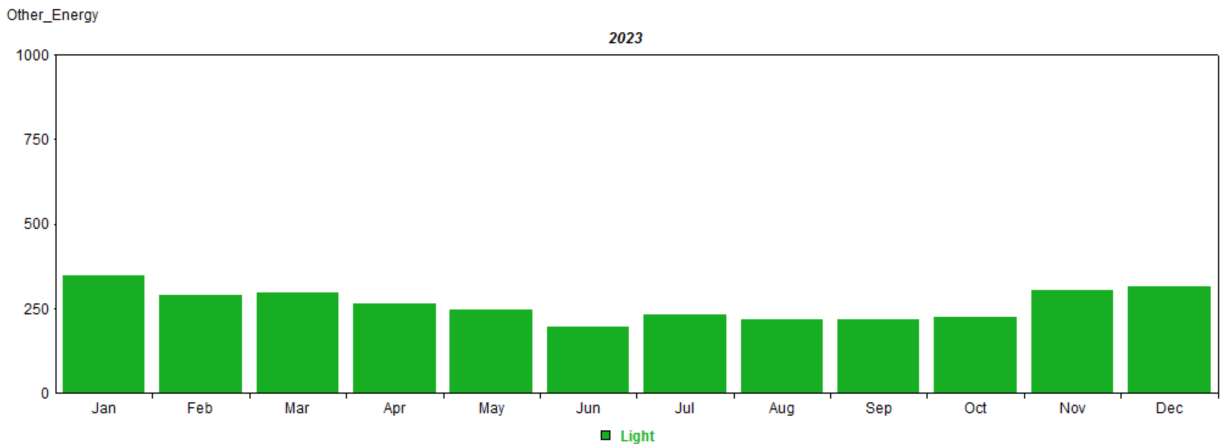


Table 37: Data Table Other KS Metro Load (Lighting)

Date	Light
Jan-23	347.17
Feb-23	288.42
Mar-23	296.88
Apr-23	265.03
May-23	247.88
Jun-23	197.63
Jul-23	232.43
Aug-23	217.99
Sep-23	218.93
Oct-23	225.92
Nov-23	302.9
Dec-23	315.62

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

7.1.5 Describe and Document Modification of Models[63]

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[64]

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[65]

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.

[63] 20 CSR 4240-22.030(7)(A)(5)
[64] 20 CSR 4240-22.030(7)(A)(6)
[65] 20 CSR 4240-22.030(7)(A)(7)

Figure 40: Base Year (2023) Net System Load Profiles for MO Metro, KS Metro, and System

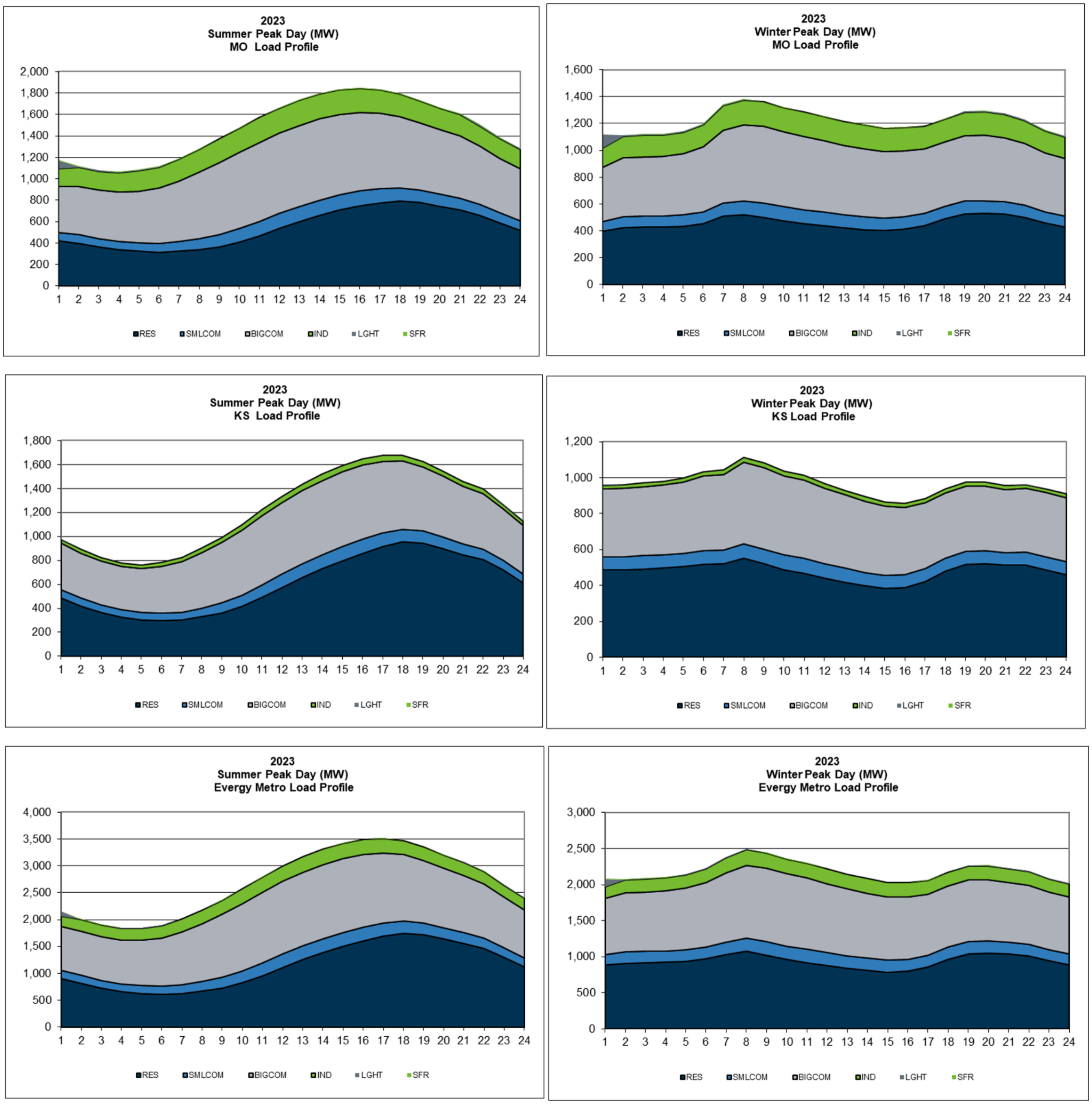


Figure 41: Fifth Year (2028) Net System Load Profiles for MO Metro, KS Metro, and System

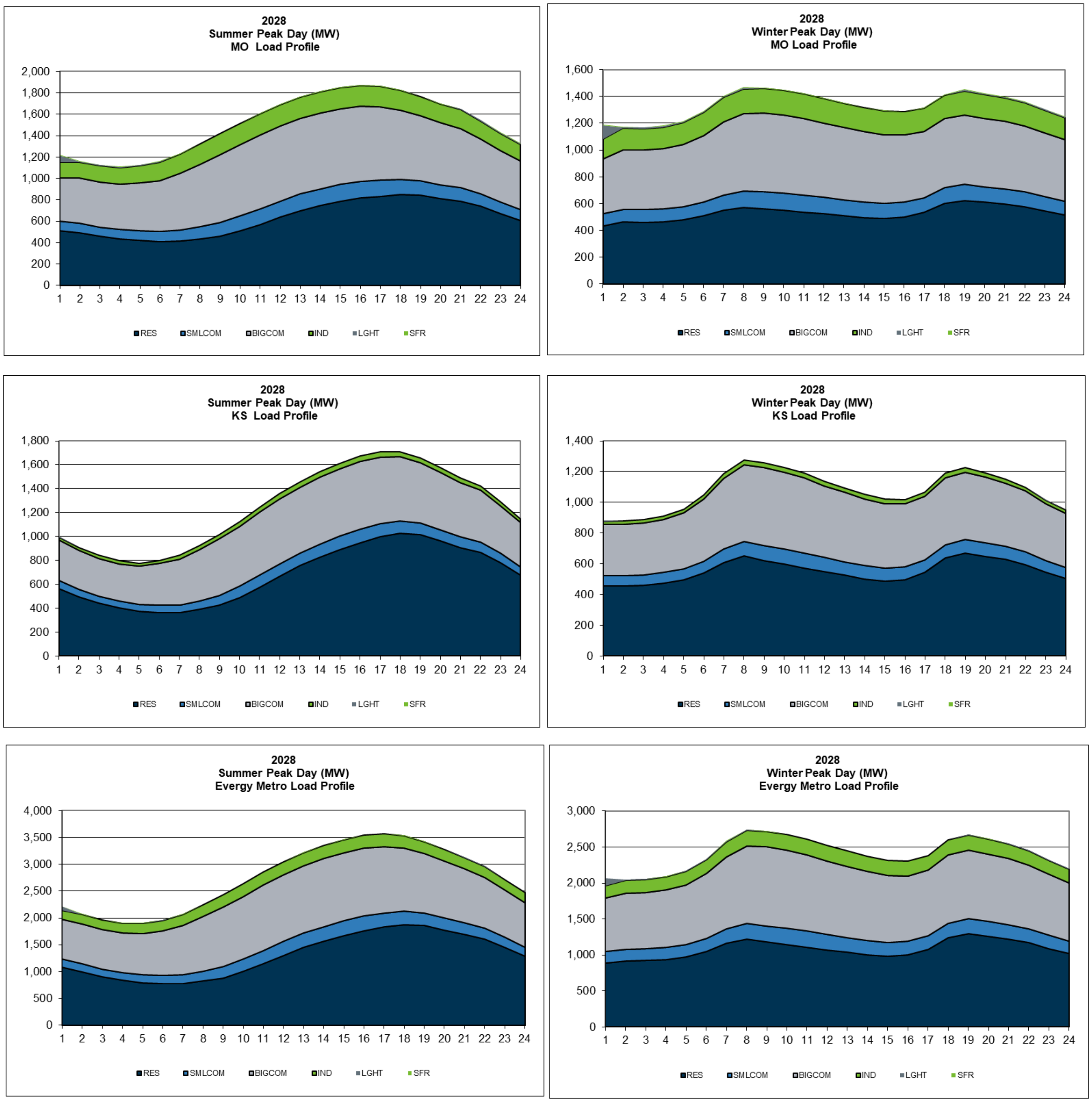
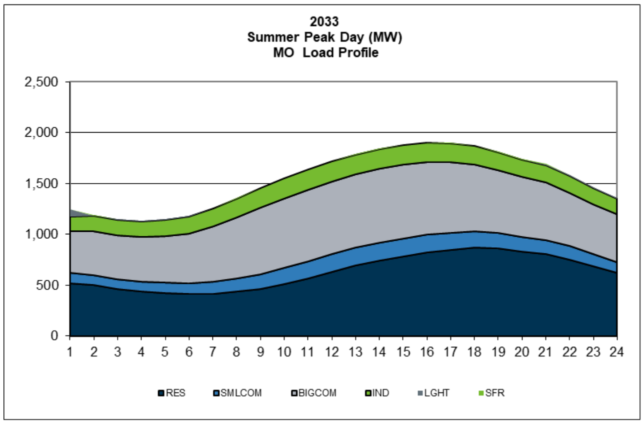
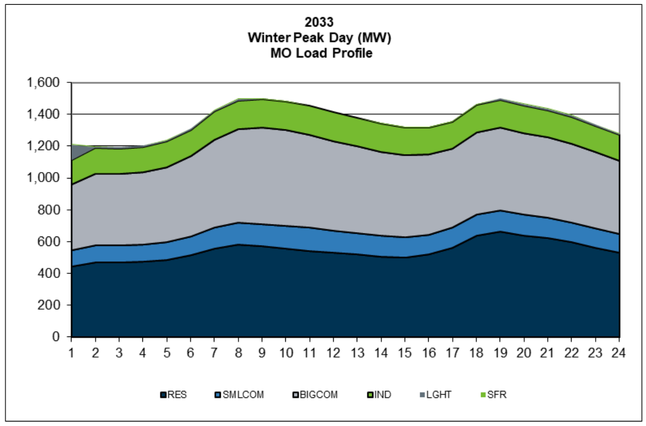
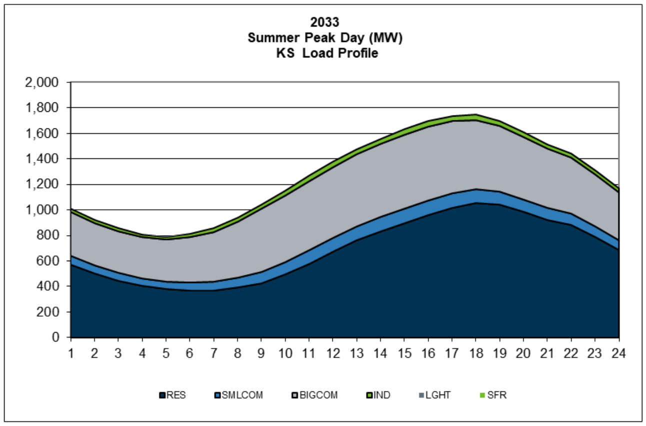
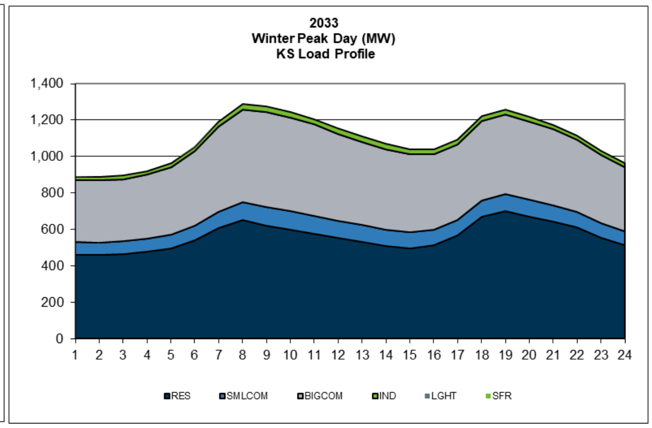


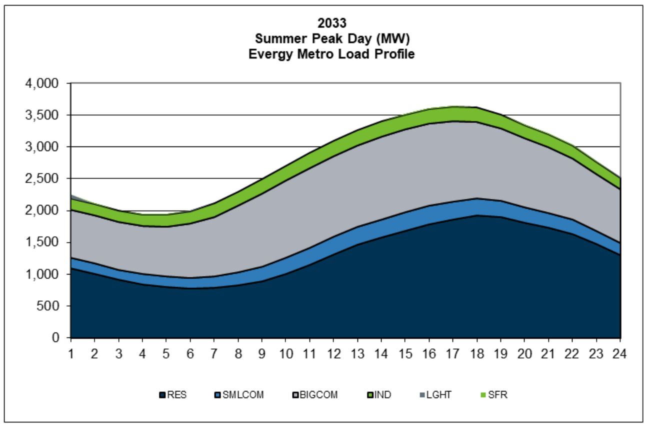
Figure 42: Tenth Year (2033) Net System Load Profiles for MO Metro, KS Metro, and System











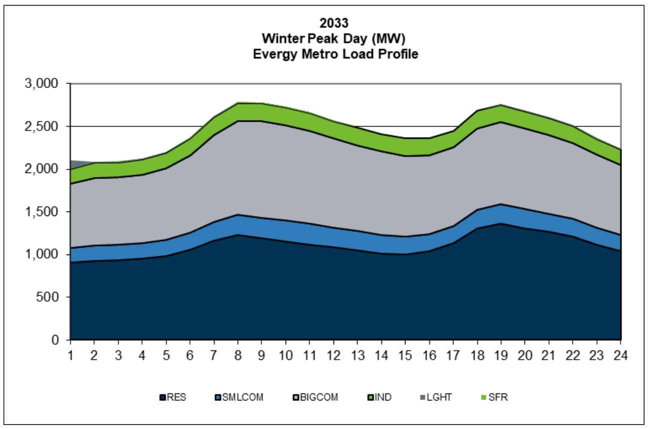
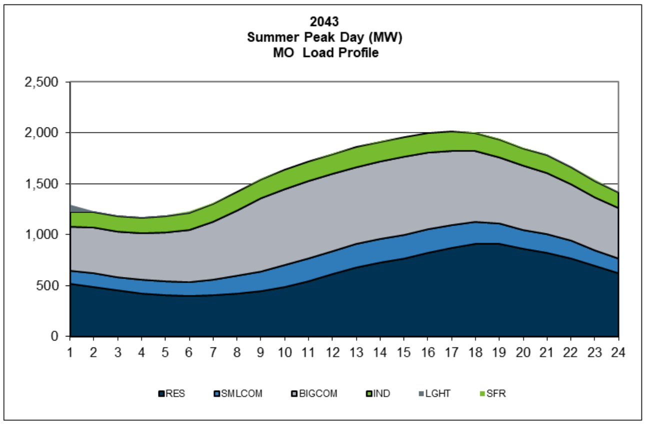
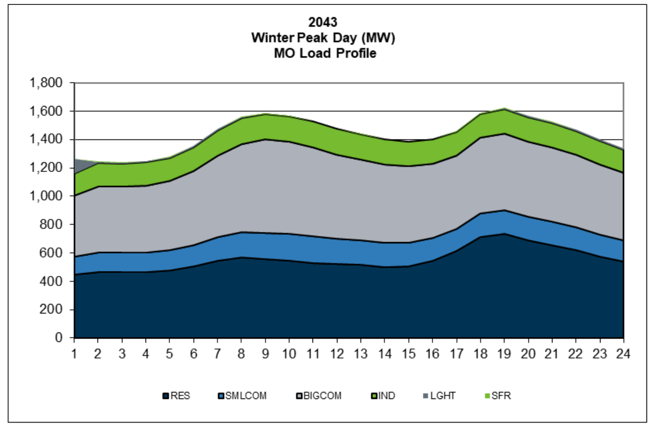
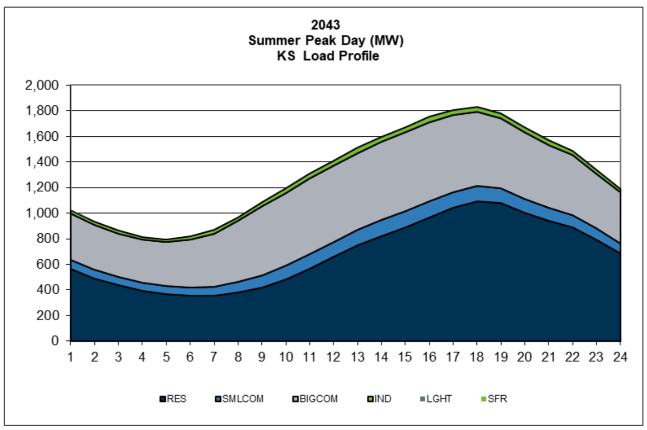
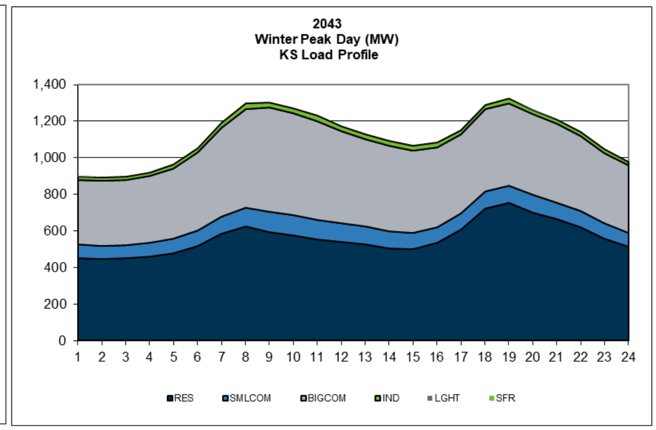


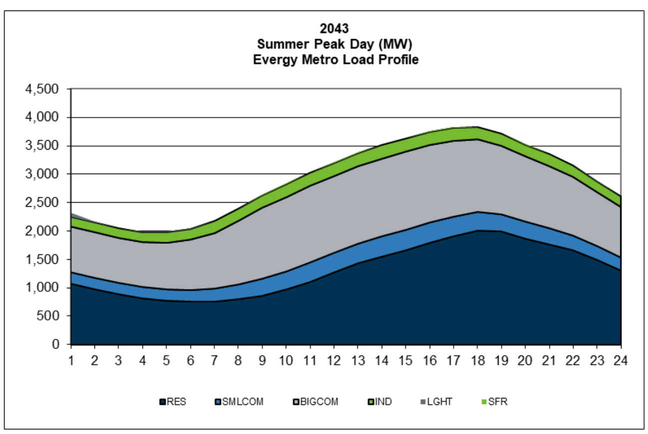
Figure 43: Twentieth Year (2043) Net System Load Profiles for MO Metro, KS Metro, and System

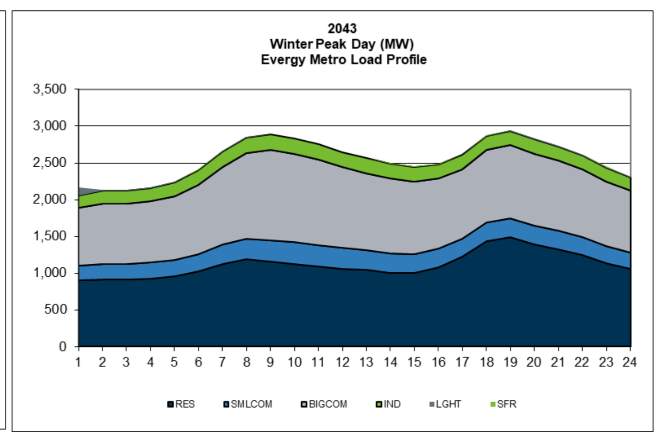












7.2 Describe and Document Forecasts of Independent Variables[66]

The forecasts of independent variables were described above in the section for rule 20 CSR 4240-22.030(6)(C)(3) and below in the section for rule for 20 CSR 4240-22.030(7)(B)(3)

7.2.1 Documentation of Mathematical Models Developed by the Utility[67]

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

7.2.3 Documentation of Adopted Forecasts Developed by Another Entity[68]

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.

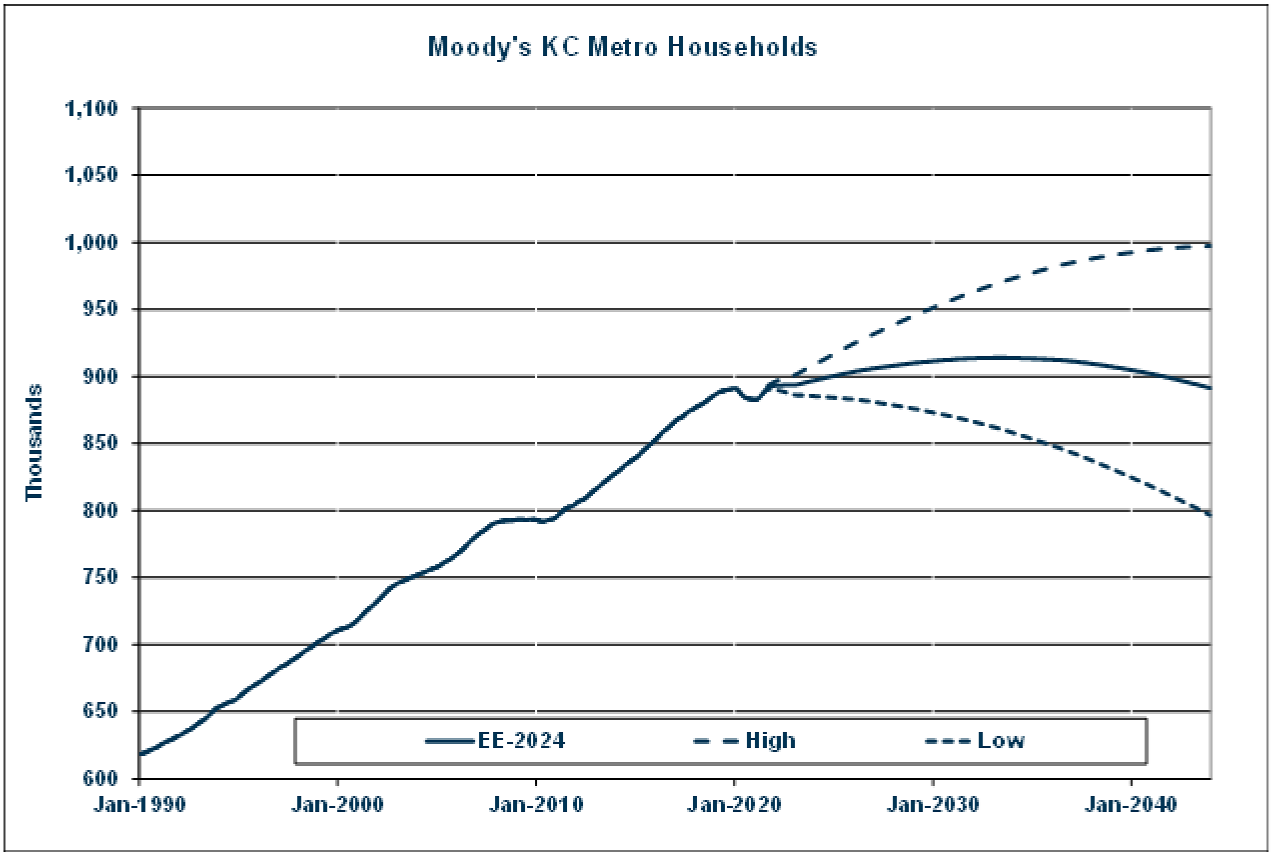
7.2.4 Comparison of Forecast from Independent Variables to Historical Trends[69]

Table 38: Economic Growth Rates for KC Metro Area **<u>Confidential</u>**

[redacted]

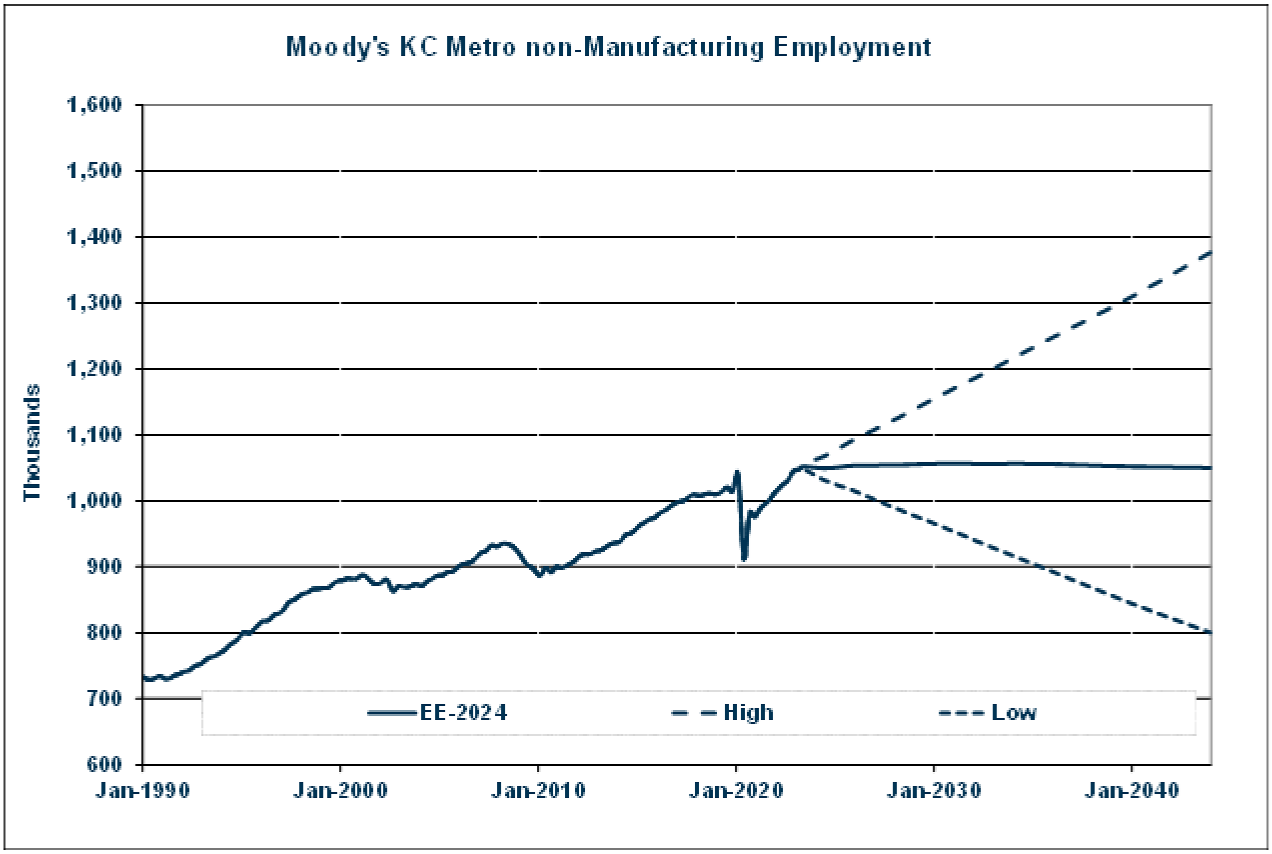
[66] 20 CSR 4240-22.030(7)(B)
[67] 20 CSR 4240-22.030(7)(B)(1)
[68] 20 CSR 4240-22.030(7)(B)(2)
[69] 20 CSR 4240-22.030(7)(B)(3)

Figure 44: KC Metro Households



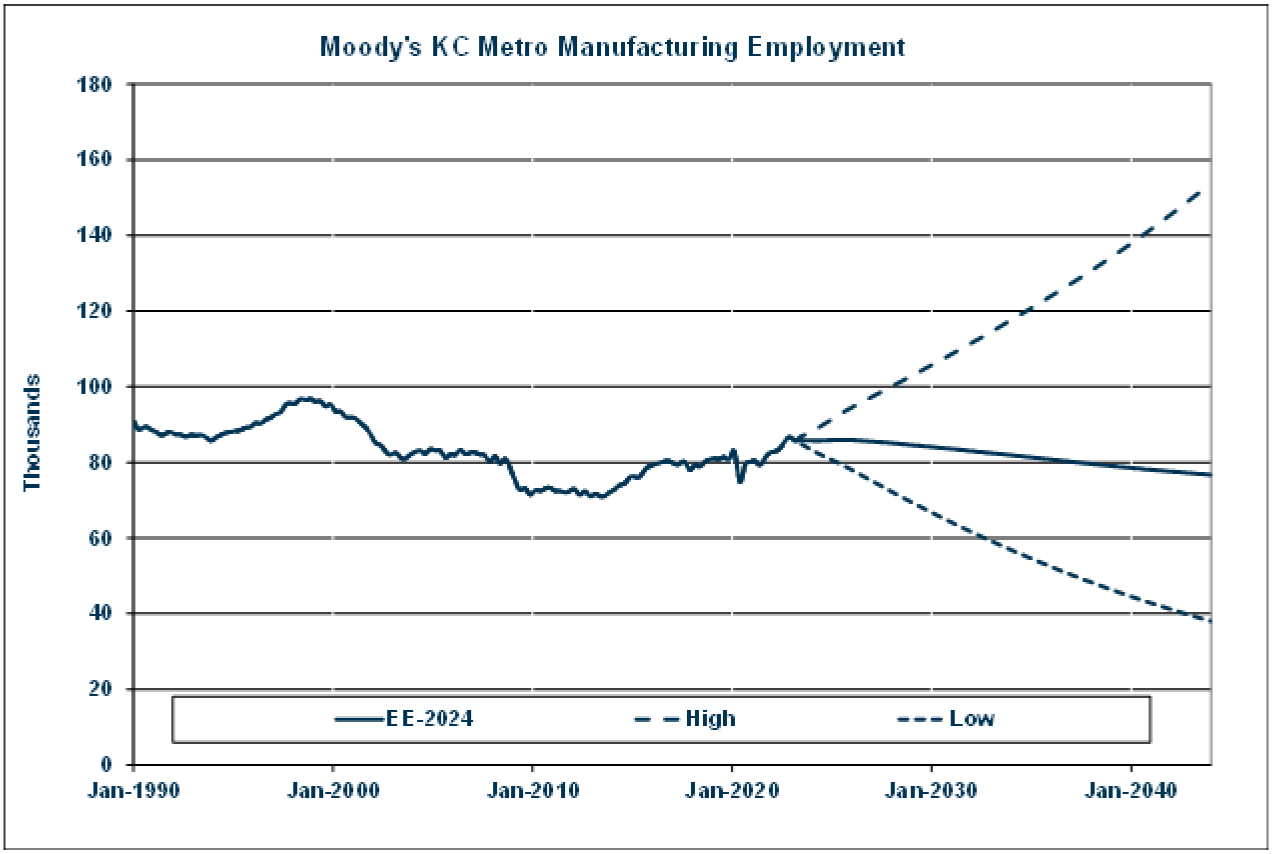
The household data and projection show robust growth from 1990 until the beginning of the last recession at the end of 2007, at which time growth slowed substantially. Housing stock has expanded since 2012 and the growth is expected to continue at a slowly decelerating pace until 2030 when the pace begins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

Figure 45: KC Metro Employment Non-Manufacturing



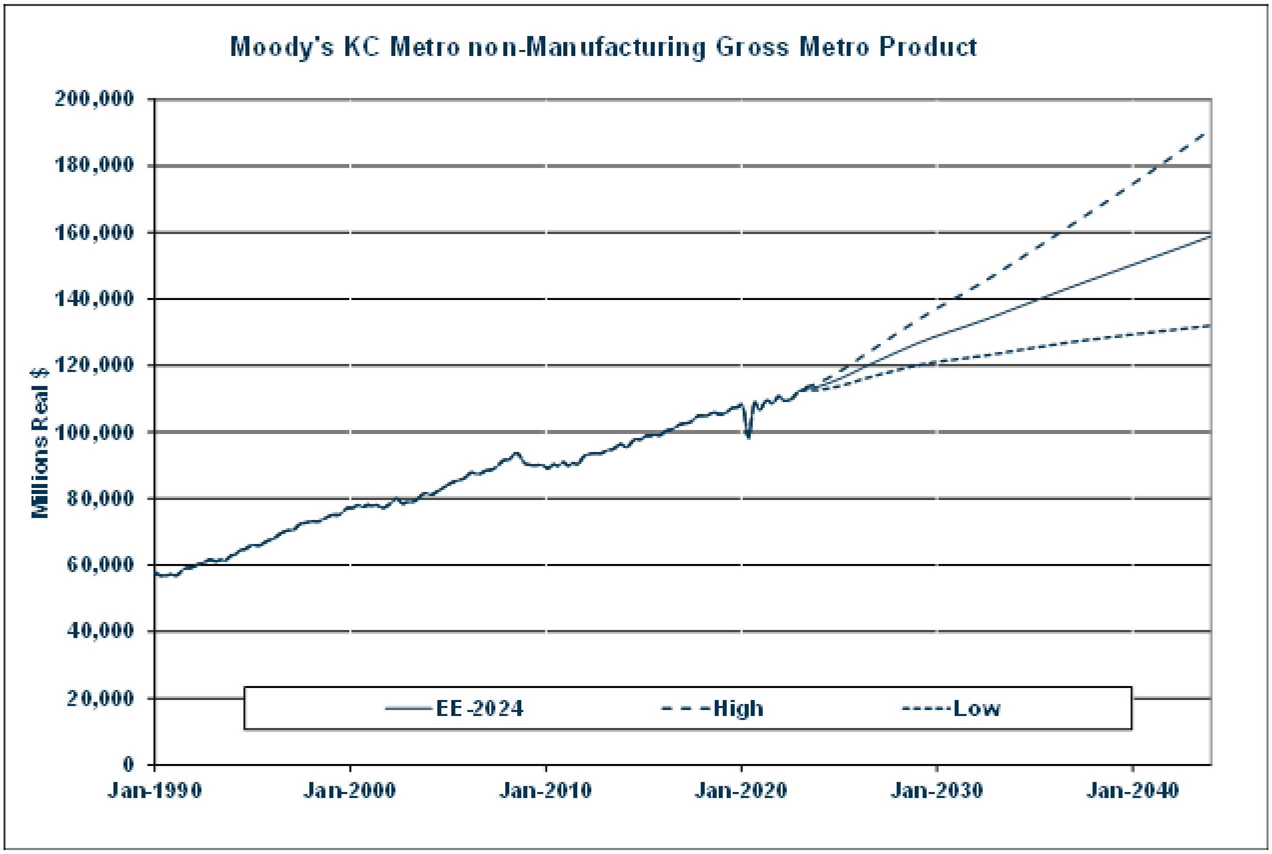
Non-manufacturing employment showed very strong growth in the 1990s, 1.9% per year, then stalled after the 2001 recession, picked up strongly in 2004 and then turned negative during the last recession. Growth returned in 2012 and grew stronger starting in 2015. Moody's expects very little growth throughout the forecast period, due in part to a slowdown and eventual decline in population.

Figure 46: KC Metro Employment Manufacturing



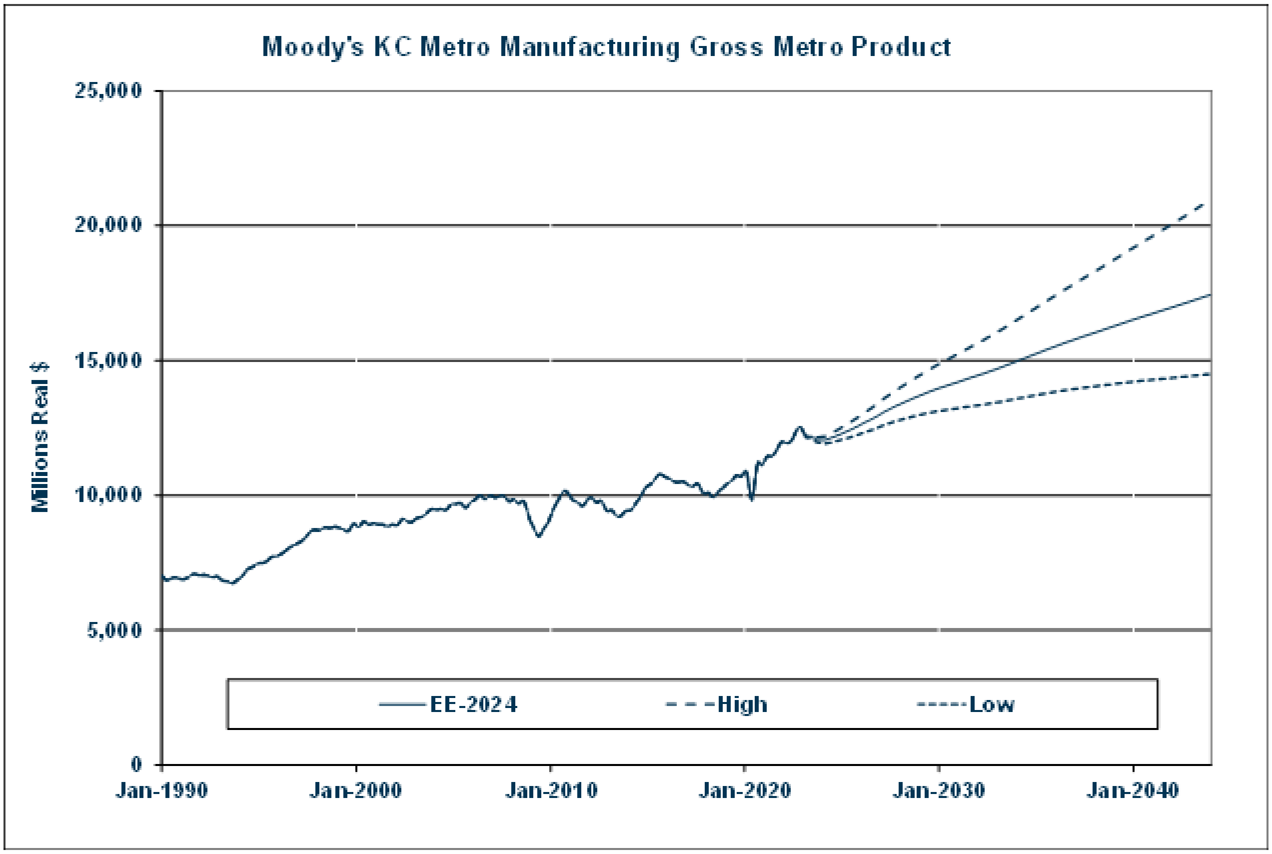
Manufacturing employment peaked in the late 1990s and has fallen since. It fell precipitously between 1999 and 2003 and again during the last recession. After regaining some of the jobs lost in the aftermath of the last recession, Moody's expects employment to resume its historical decline.

Figure 47: KC Metro Gross Metro Product Non-Manufacturing



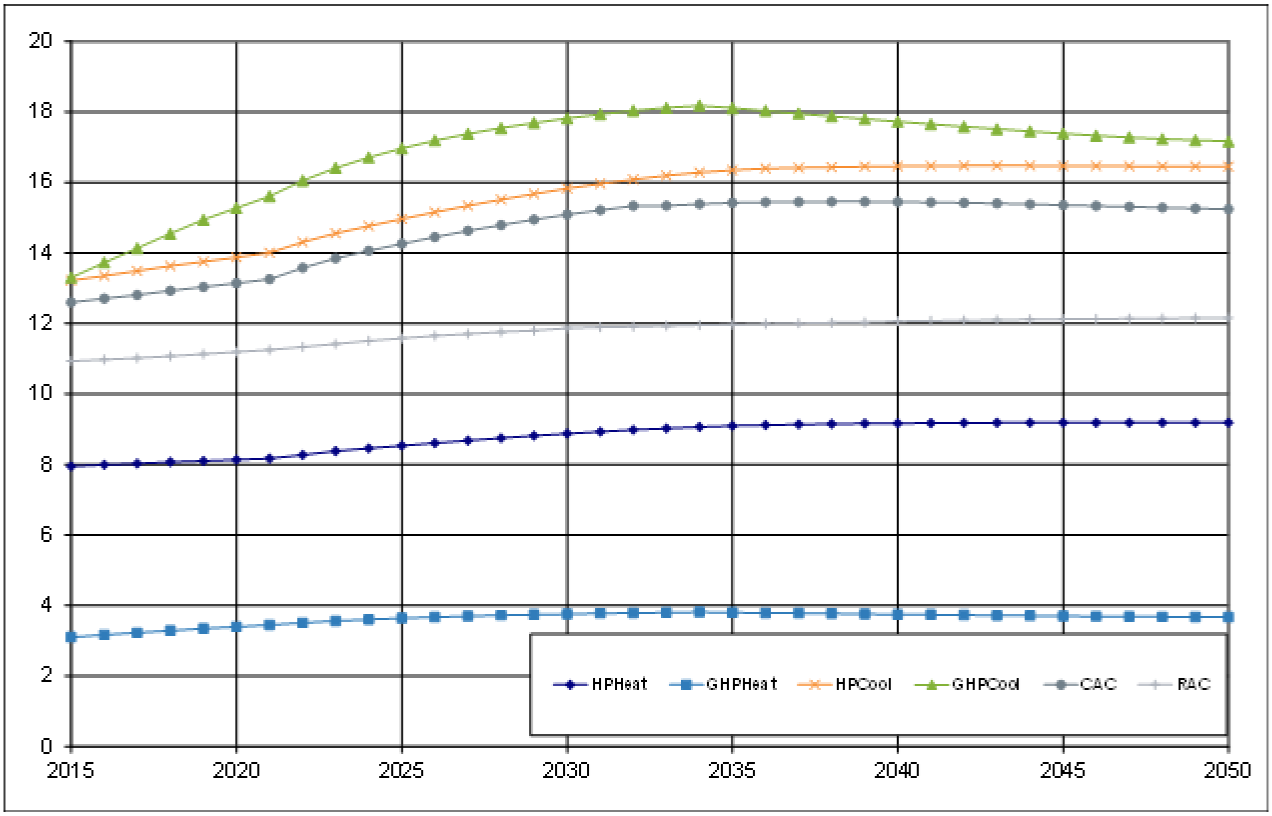
Real non-manufacturing gross metro product grew 3% per year during the 1990s, slowed down a bit after that and then declined during the last recession. GMP is growing faster than employment because of increasing productivity, a trend seen nationally and across many service sectors. Moody's expects strong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

Figure 48: Gross Metro Product Manufacturing



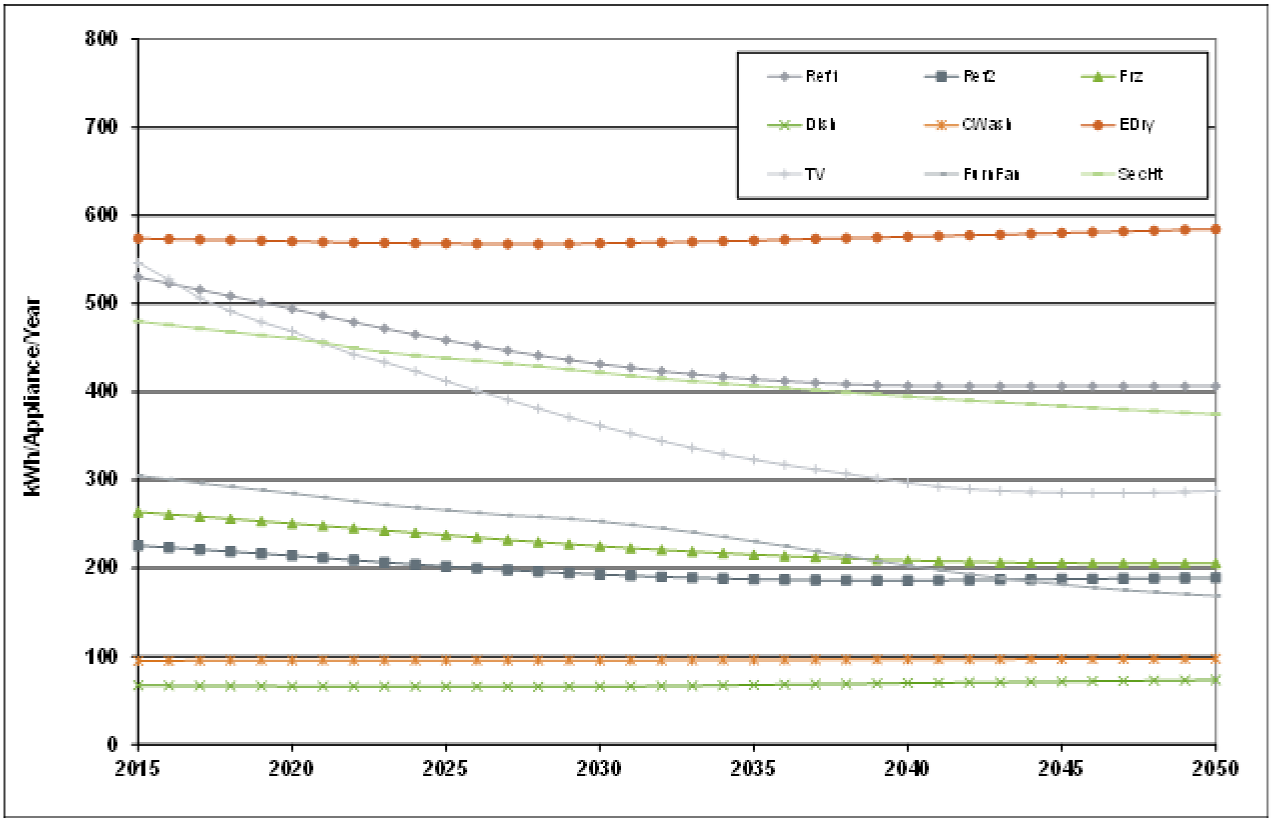
Real gross metro product from the manufacturing sector grew strongly during the 1990s and then fell flat until it plunged during the last recession. Growth has been somewhat volatile since 2008, but positive in total. Moody's expects strong growth in the forecast period. GMP for this sector is growing 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



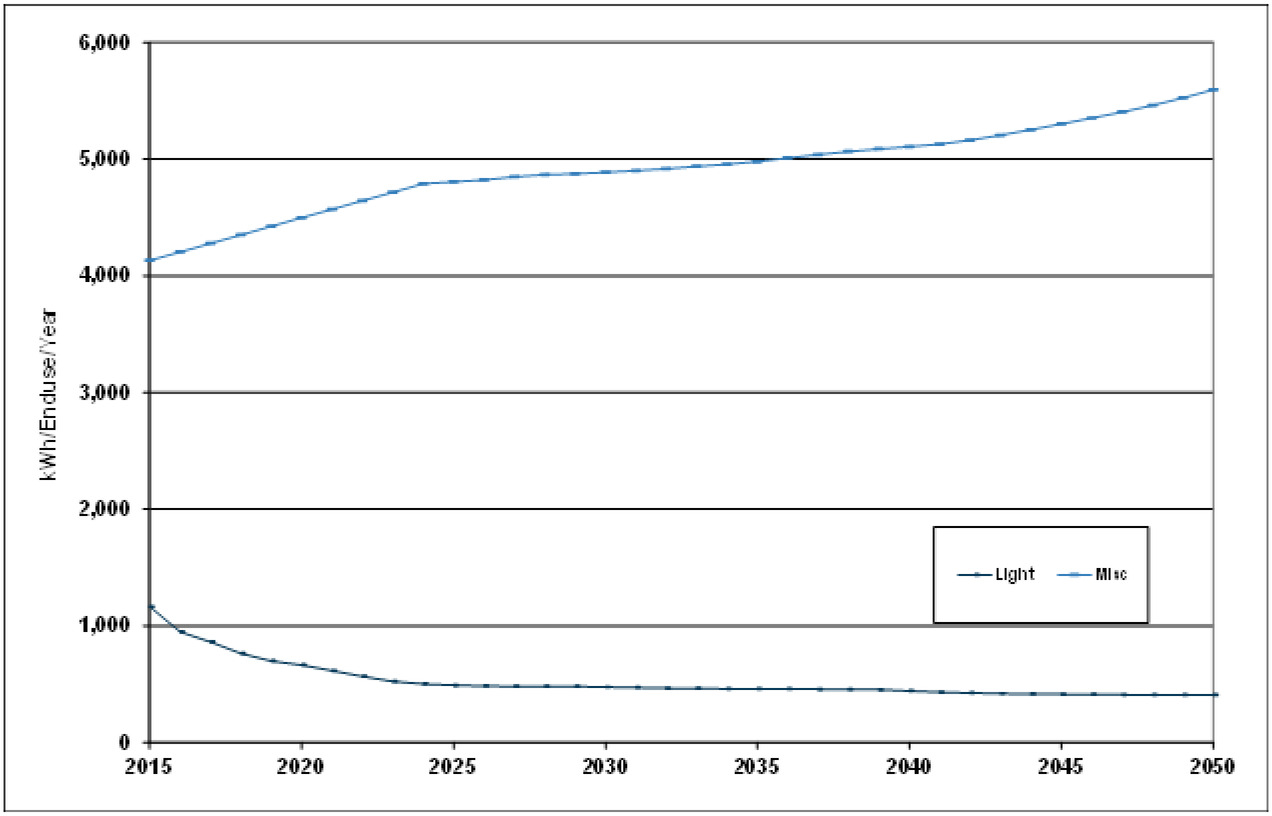
DOE is expecting increases in the stock average appliance efficiencies for residential heating and cooling equipment, resulting from appliance standards. The standards impact the stock average efficiency both due to new construction and replacement units.

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 and is expected to continue. 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.

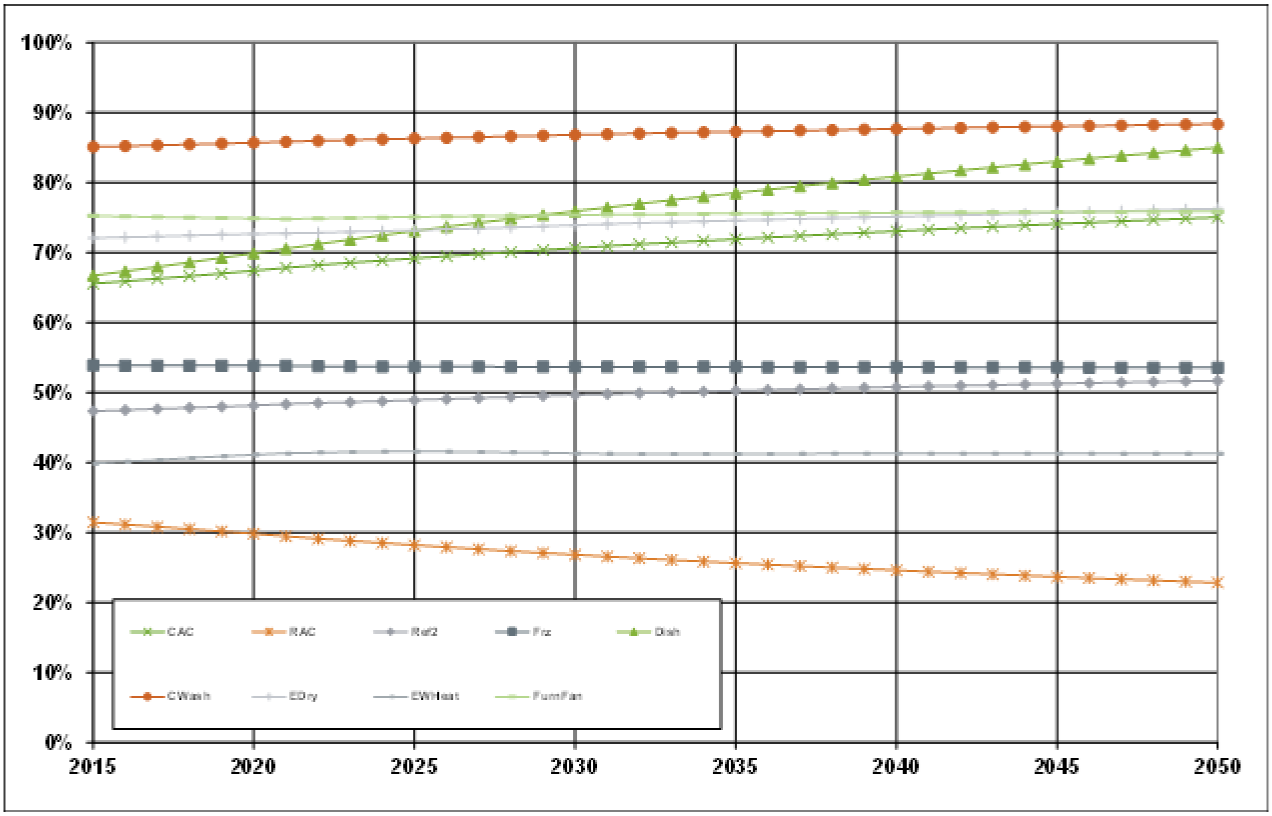
Figure 51: DOE UEC Projections (>1000 kWh/year)



Much of the decline in Lighting UEC has been realized through the adoption of LED and fluorescent lighting over incandescent. Lighting standards, many of which began in 2007 through 2015, will continue to impact consumption, though to a lesser degree, as less efficient incandescent and fluorescent lights are replaced with LED.

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 through the forecast period.

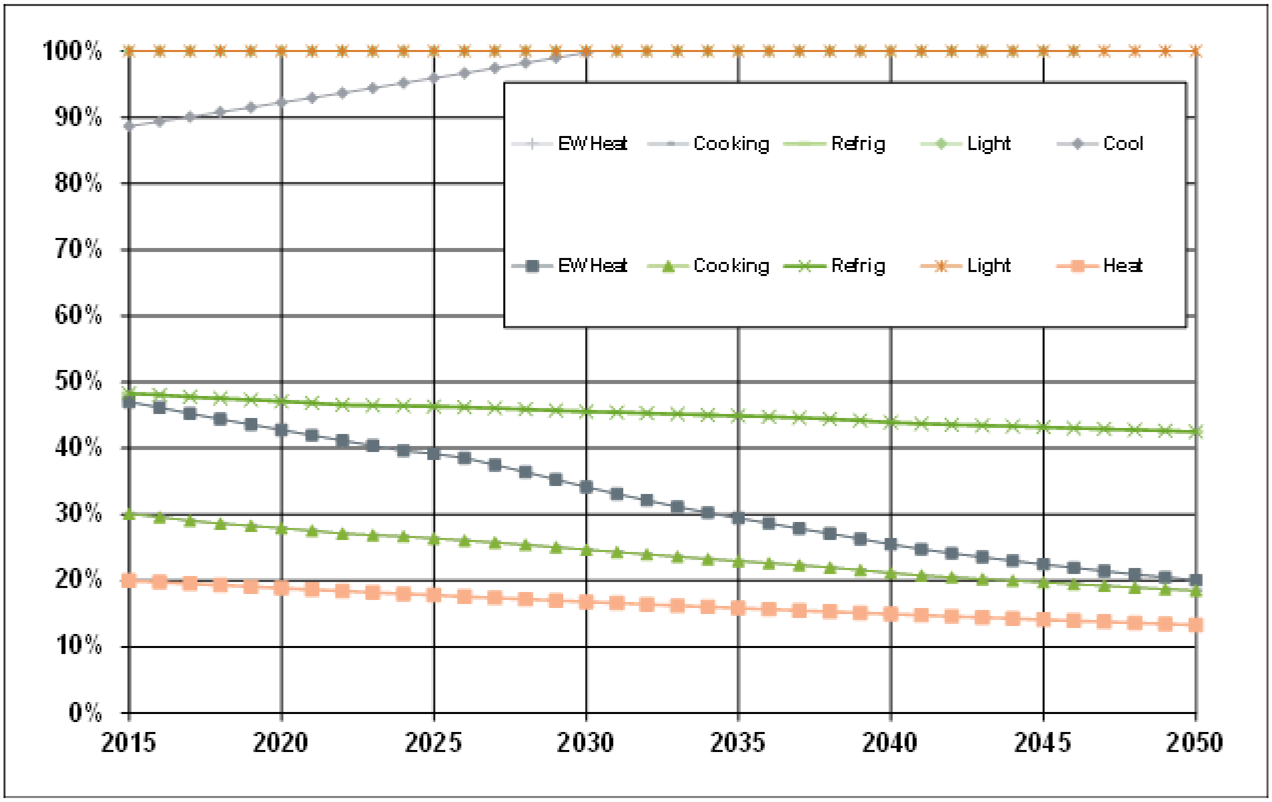
Figure 52: DOE Electric Appliance Saturation Projections (< 100%)



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

Figure 53: DOE Equipment Saturation Projections

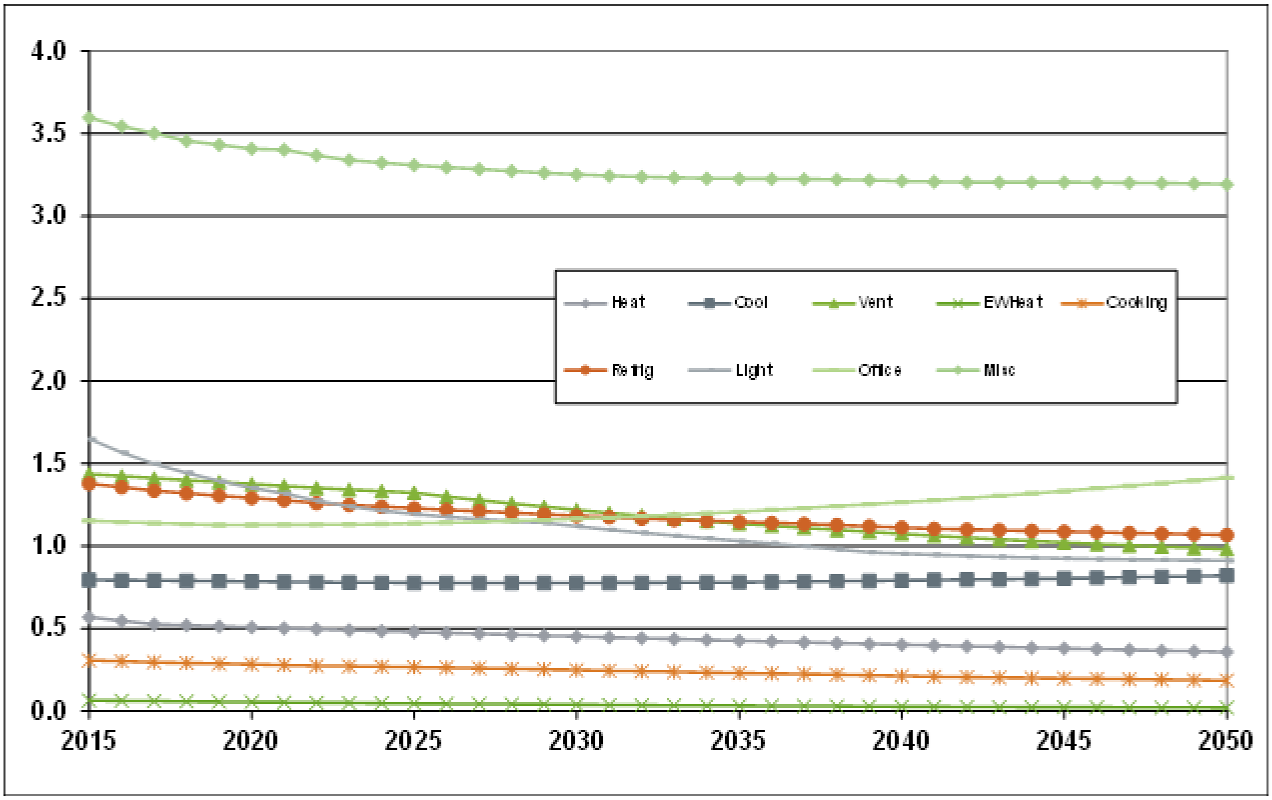
(Average over all Commercial Building Types)



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

Figure 54: DOE Commercial EUI Projections

(Average over all Commercial Building Types)



DOE estimates of the EUI for lighting have been declining since 1995 and started falling more rapidly in 2012, due to CFLs and LEDs, especially for lodging and in recessed fixtures in offices. New refrigeration standards became effective in 2017.[v] The heating EUI is declining and expected to further decline. A new standard for commercial heating and cooling equipment became effective in 2017.[vi] The EUI for miscellaneous equipment was revised lower than previous outlooks due to the incorporation of the 2012 CBECS.

7.2.5 Specification and Quantification of Factors[70]

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

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[70] 20 CSR 4240-22.030(7)(B)(4)

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[71]

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

[71] 20 CSR 4240-22.030(7)(C)

Section 8: Load Forecast Sensitivity Analysis[72]

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 2023.

The table below displays the results for MO residential customers. Among the driving variables, the cooling degree days’ variable has the largest standardized coefficient, followed by billing days and heating degree days variables. Note that the base temperature for the cooling degree days’ variable was 650 F and the base temperature for the heating degree days variable was 550 F. The variable hddPriceRatio variable is heating degree days with a base temperature of 550 F times the price of natural gas for the West North Central Region. This variable's purpose is to measure gas and electric prices' impact 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 regression periods used for these regressions are monthly from January 2001 to June 2023 or January 2002 to June 2023.

[72] 20 CSR 4240-22.030(8)

Table 39: Missouri Metro Residential

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
BDays	3,705,848	7.7	0.55
Population	1,961,923	1.9	0.16
hddPriceRatio	8,697,130	3.2	0.03
resCusCDD65	67,610,168	90.8	0.25
resCusHdd55	34,572,324	12.3	0.14
HDDtrend	10,447,745	6.9	0.01
CDDtrend	-2,428,255	-3.0	0.00
Calib	-5,482,932	-4.1	-0.12
Calib2	-2,132,582	-2.6	-0.01
Covid	1,102,648	1.7	0.00
Jan23	1,667,618	3.7	0.00
Jun21	-1,409,902	-3.2	0.00
Mar21	1,260,279	2.8	0.00
Jun18	-1,122,612	-2.5	0.00

The table below 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 600 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 40: Missouri Metro Commercial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
GP_Non_Man	12,772,168	8.7	0.34
BDays	9,213,356	30.8	0.82
HDDpriceRatio	13,212,816	4.0	0.03
comCusCDD60	40,691,906	39.5	0.10
comCusHdd55	7,764,083	2.3	0.02
Jun02	-1,264,384	-2.4	0.00
Apr03	-1,361,582	-2.5	0.00
HddTrend	11,257,880	6.6	0.00
EffTrend	-18,884,047	-12.8	-0.30
COVID	-3,945,784	-5.1	0.00
Jun21	-1,518,494	-2.8	0.00

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

Table 41: Missouri Metro Industrial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
Emp_Man	3,146,525	12.0	0.54
indCus	5,258,857	11.0	0.52
prElecCus	-1,419,696	-3.8	-0.09
indCusCDD60	5,368,208	11.6	0.04
Aug05	-1,411,189	-4.6	0.00
Jul19	-1,377,154	-4.5	0.00
Apr20	-746,127	-2.3	0.00
May20	-1,501,682	-4.6	0.00

The table below 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 42: Kansas Metro Residential

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
BDays	246,913,261	16.6	1.07
Population	38,798,970	1.5	0.17
hddPriceRatio	9,787,100	3.4	0.04
resCusCDD65	60,385,956	45.9	0.26
resCusHdd55	13,561,841	2.7	0.06
CDDtrend	-3,985,421	-3.5	-0.02
HDDtrend	9,762,680	4.3	0.04
COVID	2,610,355	4.1	0.01
calib	-146,074,494	-5.4	-0.63
COVID	-85,148	-3.3	0.00
calib	95,111	3.6	0.00
Jun23	99,663	2.8	0.00
May23	76,085	2.5	0.00
Feb21	55,189	2.1	0.00
Jul11	89,322	3.4	0.00

The following table 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 43: Kansas Metro Commercial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
GP_Non_Man	10,540,414	8.5	0.40
BDays	4,761,839	19.8	0.58
HDDpriceRatio	5,173,902	1.9	0.02
comCusCDD60	30,413,410	53.2	0.10
comCusHdd55	1,459,491	0.3	0.01
HDDtrend	11,210,712	4.7	0.03
BaseEffTrend	-4,493,224	-2.6	-0.12
Oct08	842,122	3.0	0.00
Sep18	-1,859,460	-6.5	0.00
Jun18	-1,049,942	-3.7	0.00
Jan23	1,240,208	4.3	0.00
COVID	-5,461,751	-4.8	-0.01
Jul21	-802,130	-2.8	0.00

The following table 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 44: Kansas Metro Industrial

VARIABLE	Standardized Coefficient	t-Statistic	Elasticity
Emp_Man	1,285,316	5.0	0.67
indCus	884,611	3.9	0.40
prElec	-531,846	-6.0	-0.21
indCusCDD60	2,300,832	21.6	0.07
Sep00	-126,366	-2.9	0.00
Dec00	150,918	3.5	0.00

8.1 Two Additional Normal Weather Load Forecasts[73]

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.

[73] 20 CSR 4240-22.030(8)(A)

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

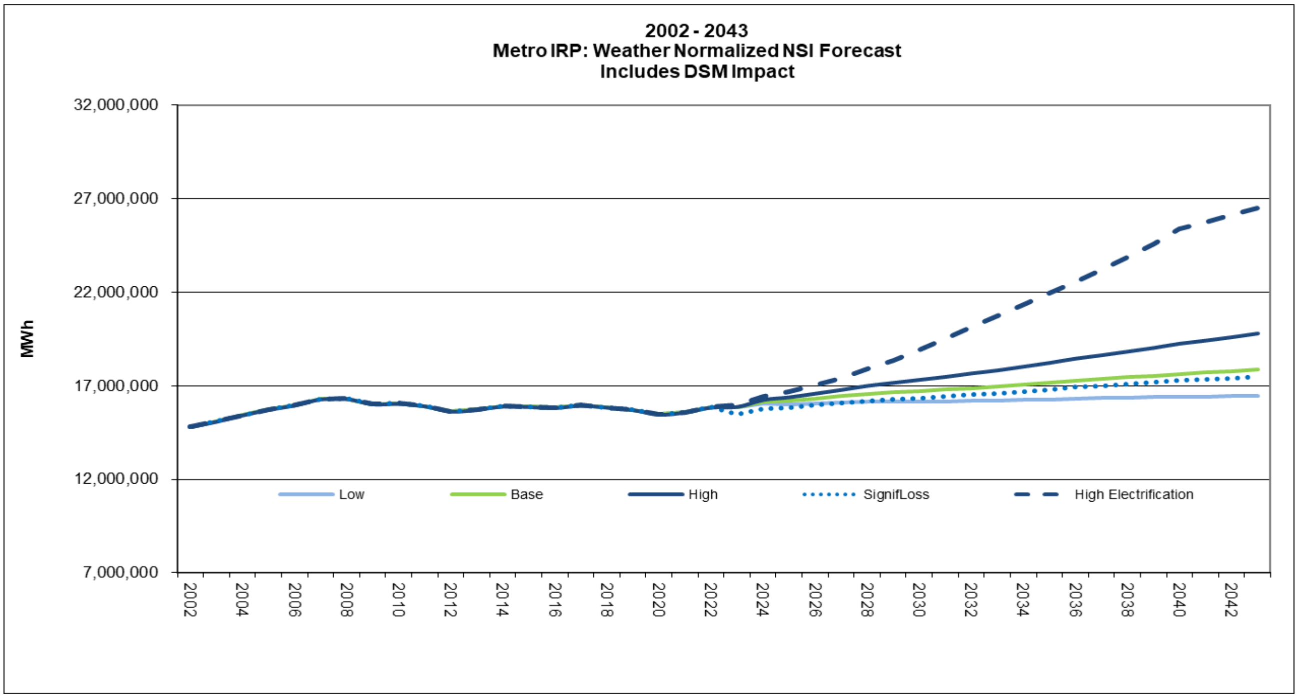
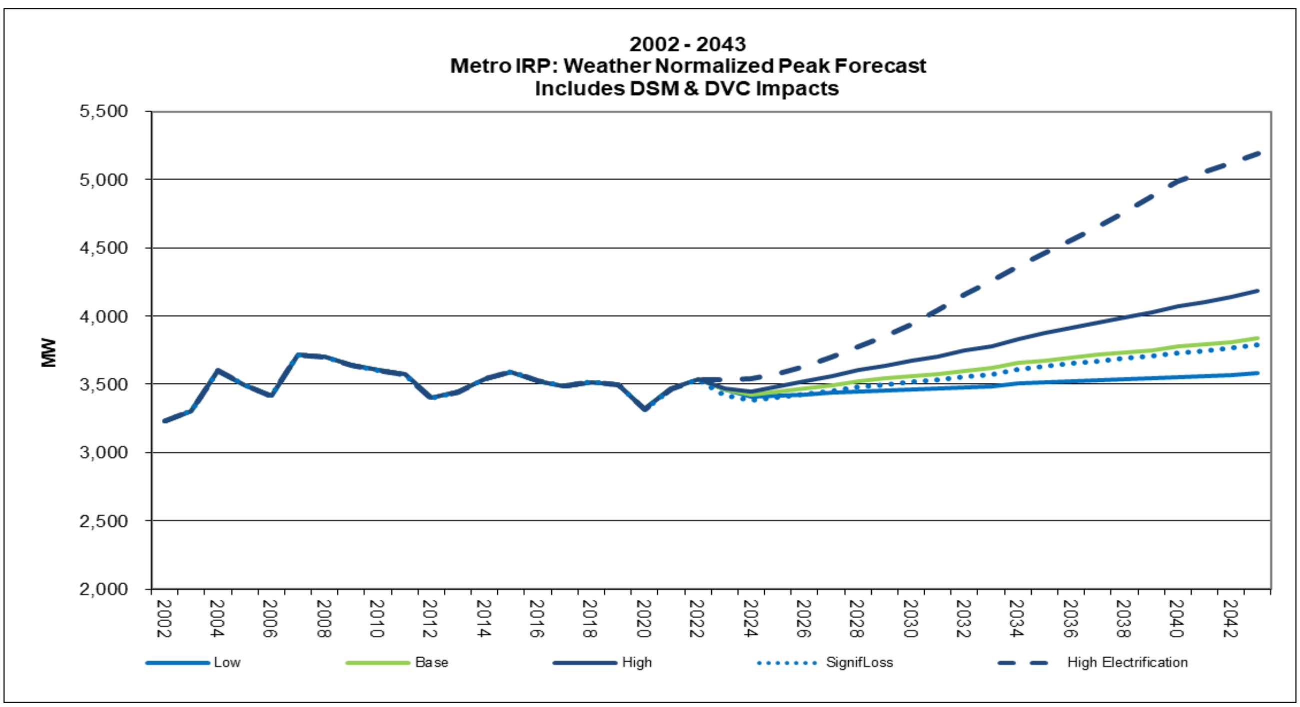


Figure 56: MO Metro Base, Low, High, Significant Loss and Electrification Peak Demand Forecast



8.2 Estimate of Sensitivity of System Peak Load Forecasts to Extreme Weather[74]

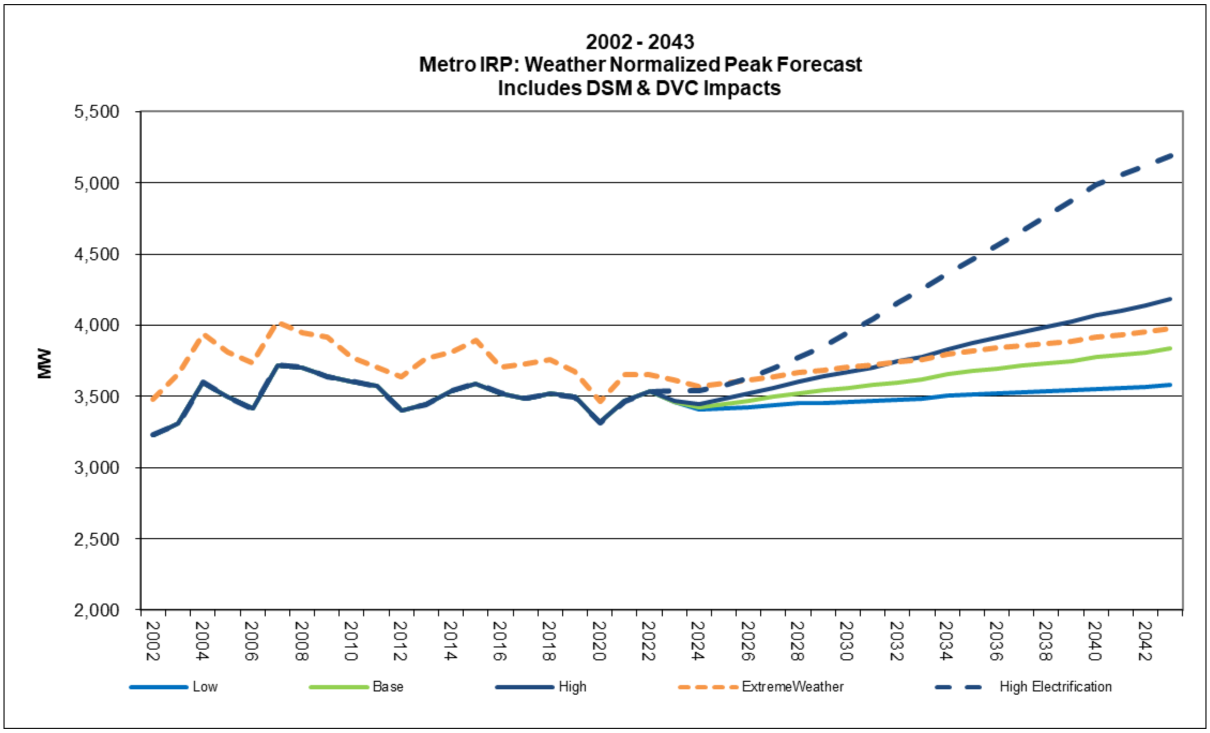
Evergy Metro created a forecast scenario using the base case economic scenario and weather from the 4 warmest years in terms of cooling degree days at KCI. These years were 1980, 1988, 2006 and 2012. The number of cooling degree days those years were 1,746, 1,724, 1,724 and 1,839. The scenario was created by running our computer programs with normal weather computed with those four years instead of with 30 years.

In 2023, the peak net of DSM rose from 3,464 MW in the base case scenario to 3,615 MW in the extreme weather scenario. In 2028, the peak net of DSM increased from 3,523 (base case) to 3,668 extreme weather scenarios. 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.

[74] 20 CSR 4240-22.030(8)(B)

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



8.3 Energy Usage and Peak Demand Plots[75]

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.

[75] 20 CSR 4240-22.030(8)(C); 20 CSR 4240-22.030(8)(C)(1); 20 CSR 4240-22.030(8)(C)(2)

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

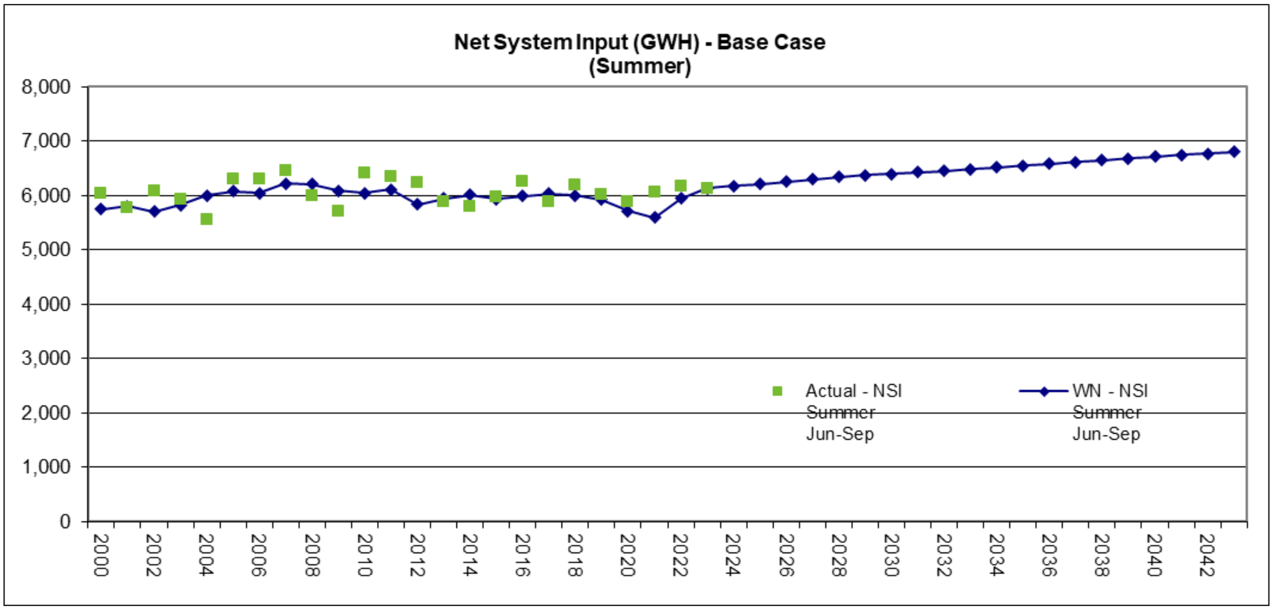


Figure 59: MO Metro Base Case Actual and Weather Normalized Non-Summer Energy Plots

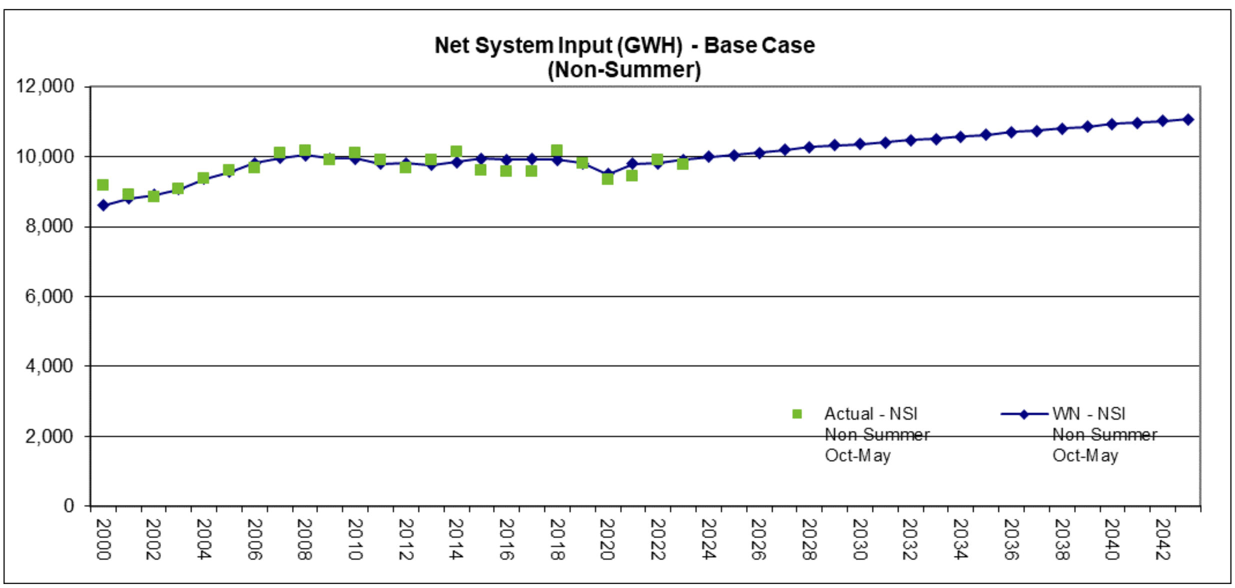
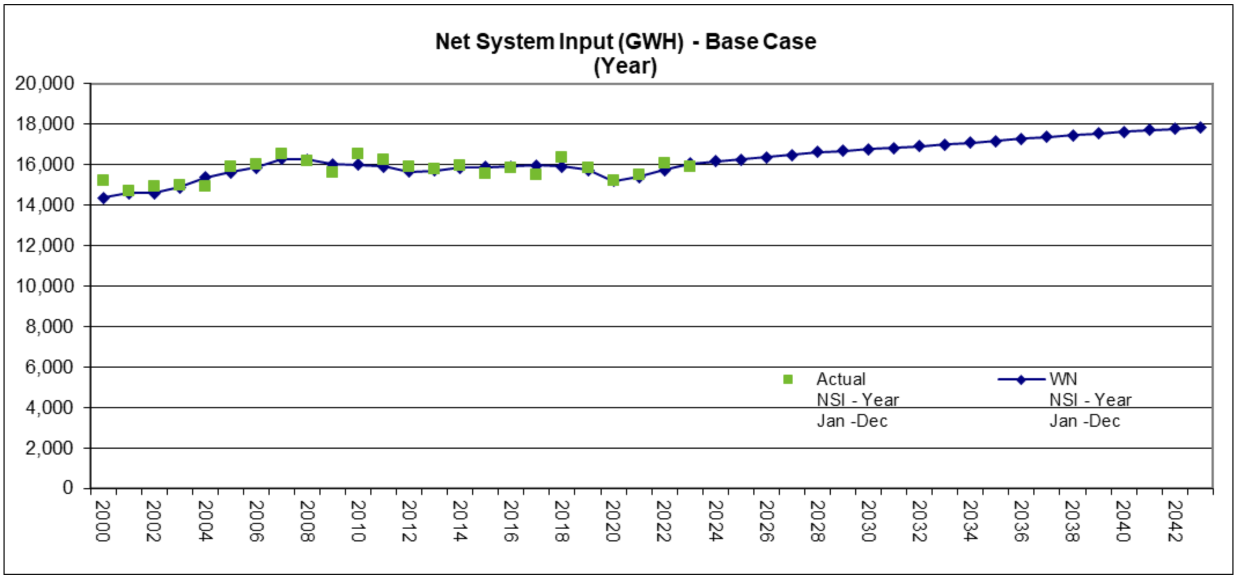


Figure 60: MO Metro Base Case Actual and Weather Normalized Total Energy Plots



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

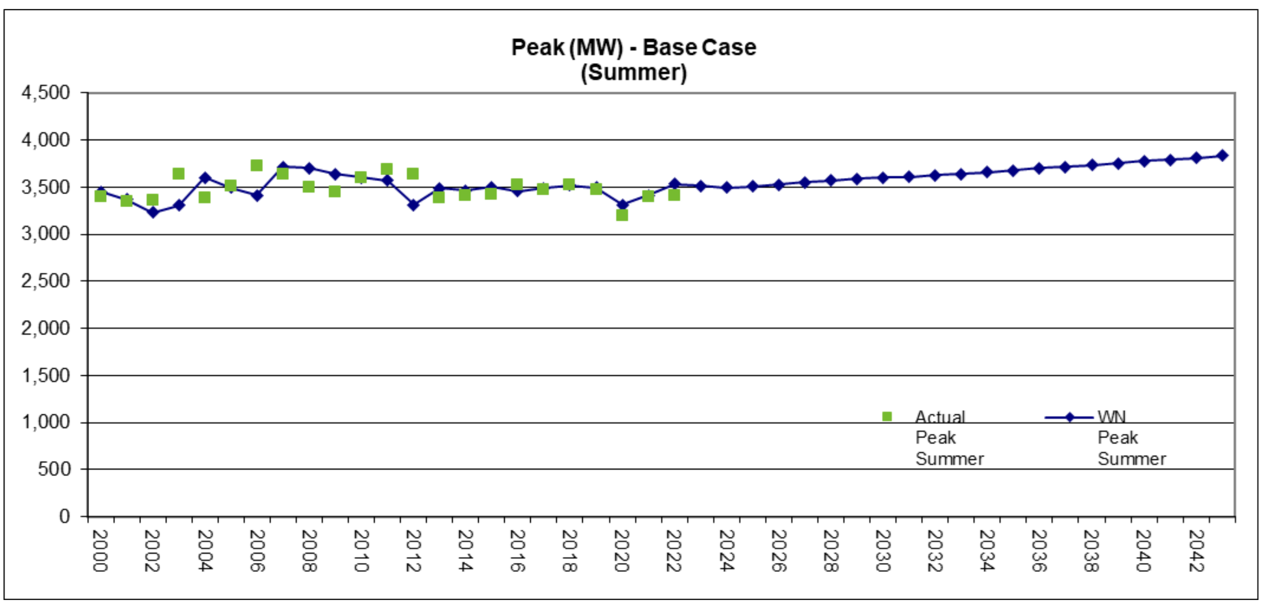
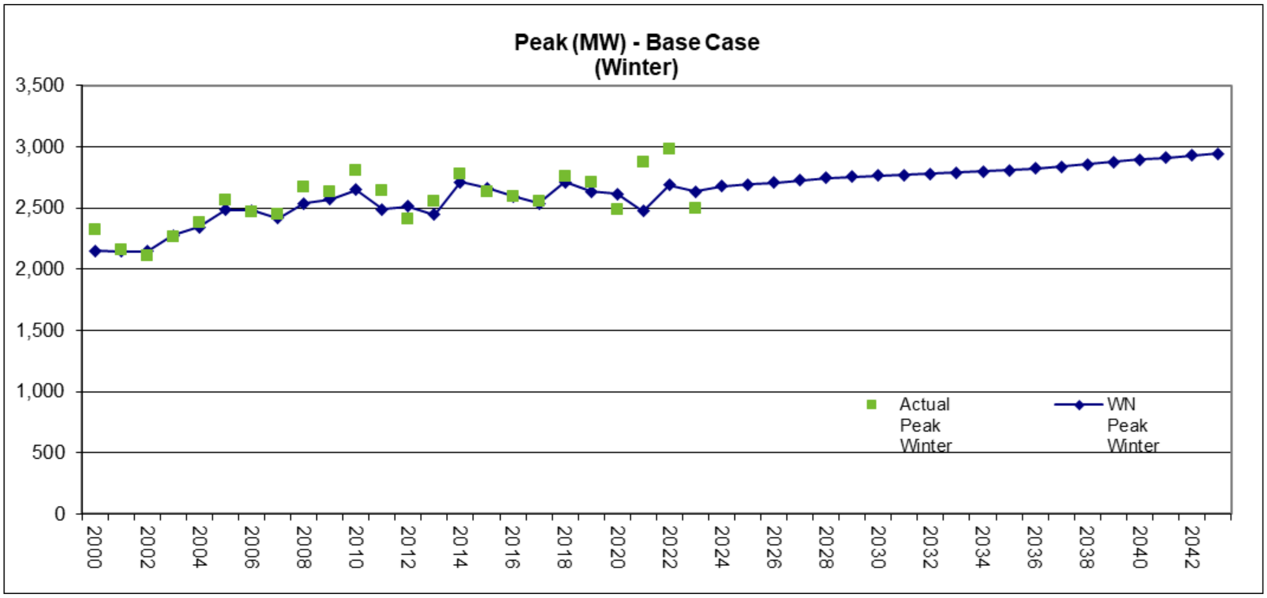


Figure 62: MO Metro Base Case Actual and Weather Normalized Winter Peak Demand Plots



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

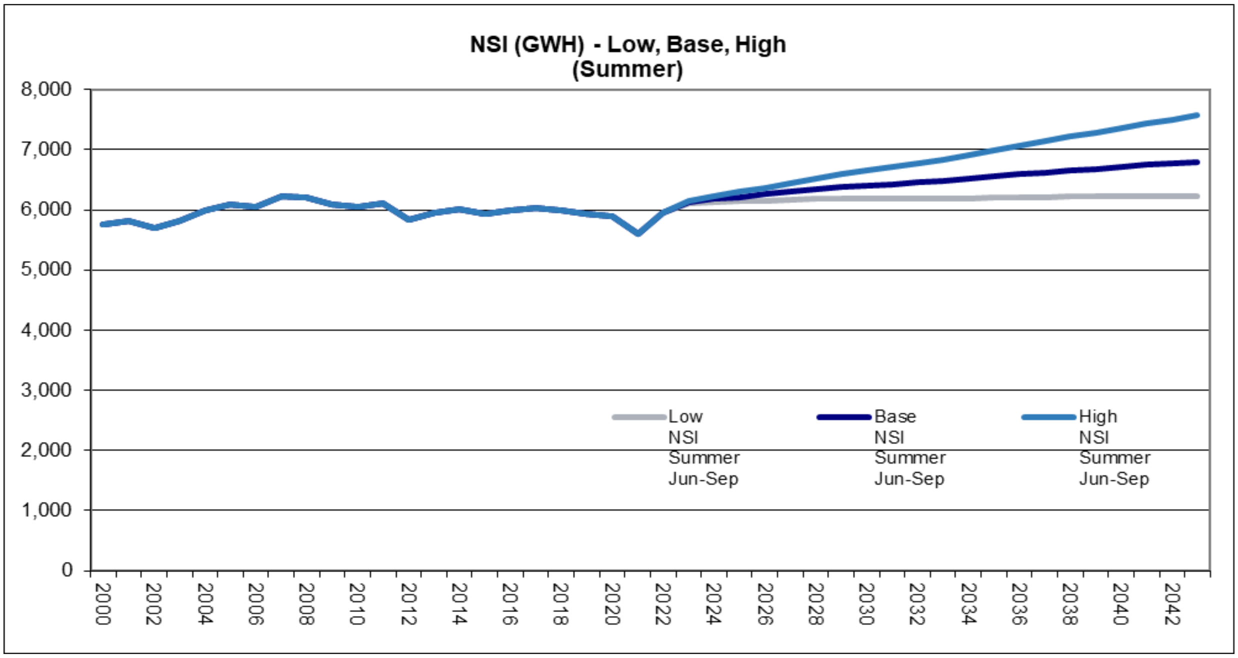


Figure 64: MO Metro Base-Case, Low-Case, and High-Case Non-Summer Energy Plots

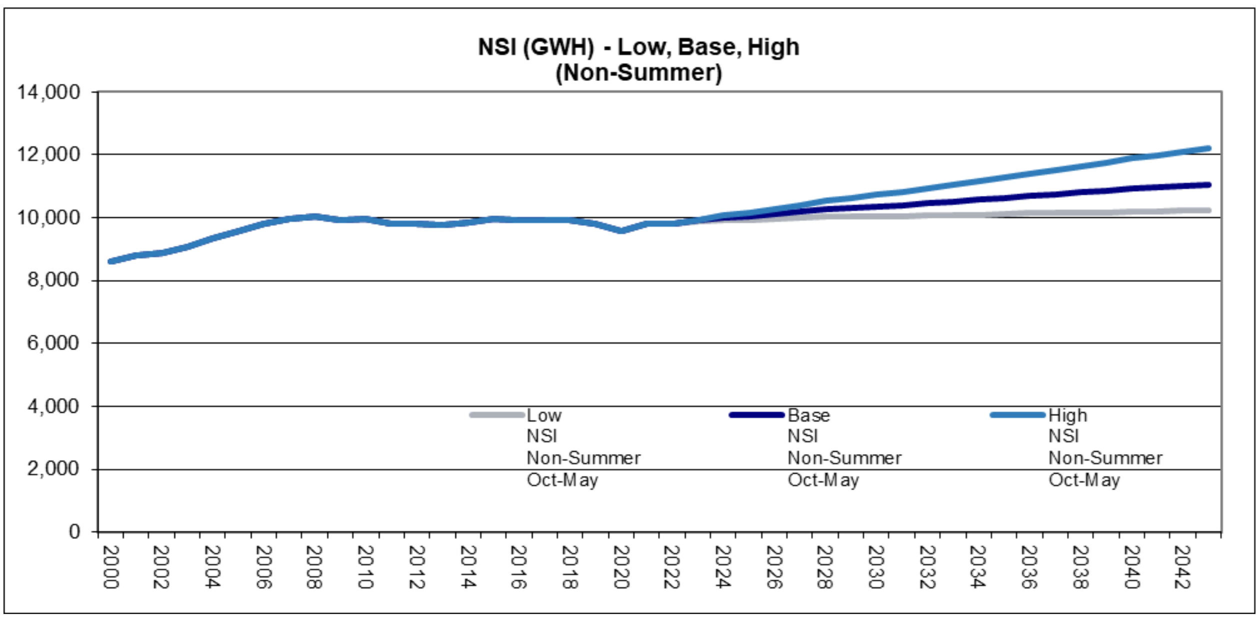
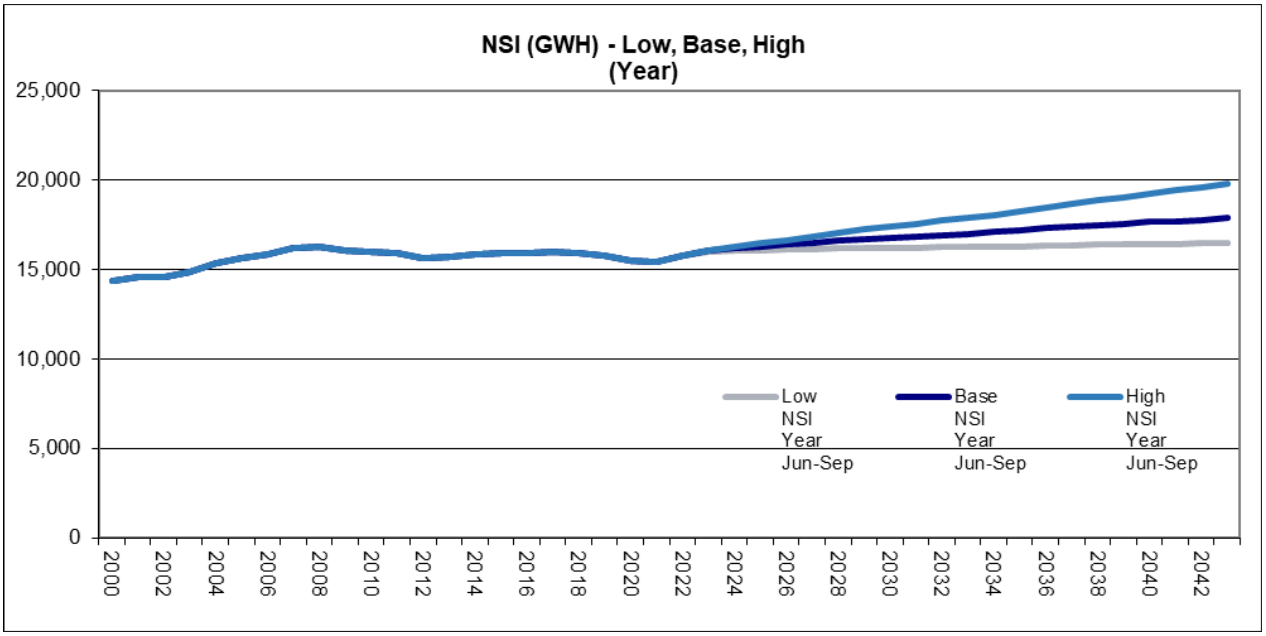


Figure 65: MO Metro Base-Case, Low-Case, and High-Case Total Energy Plots



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

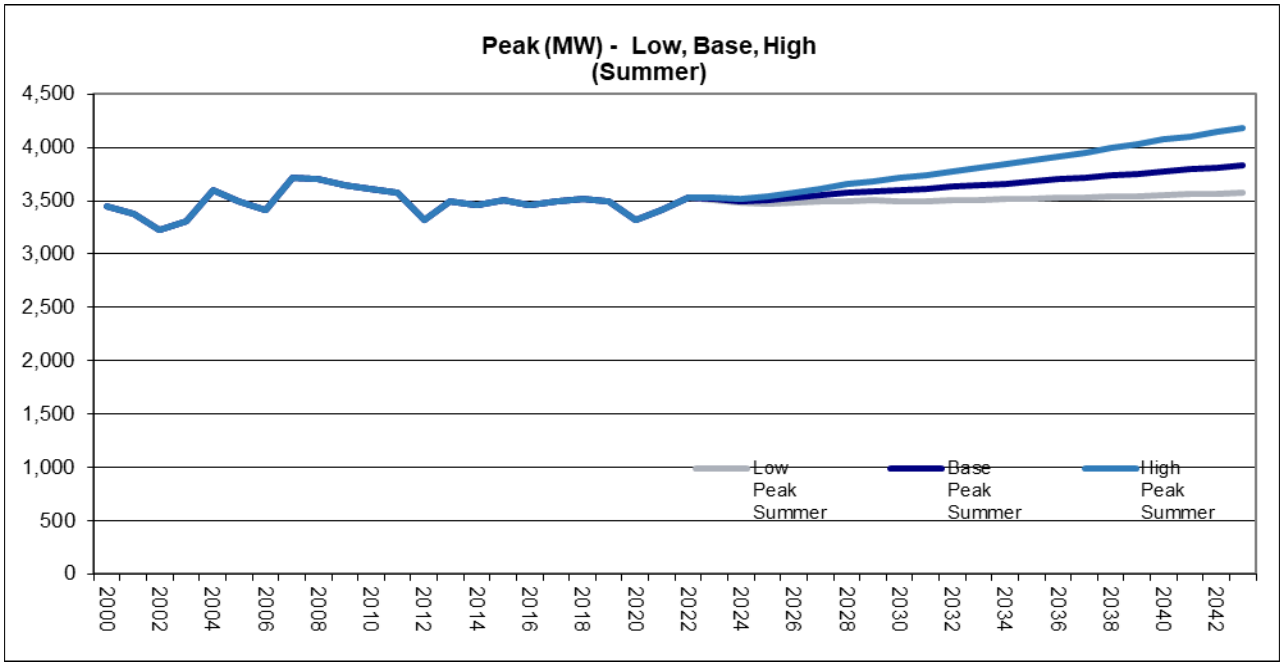
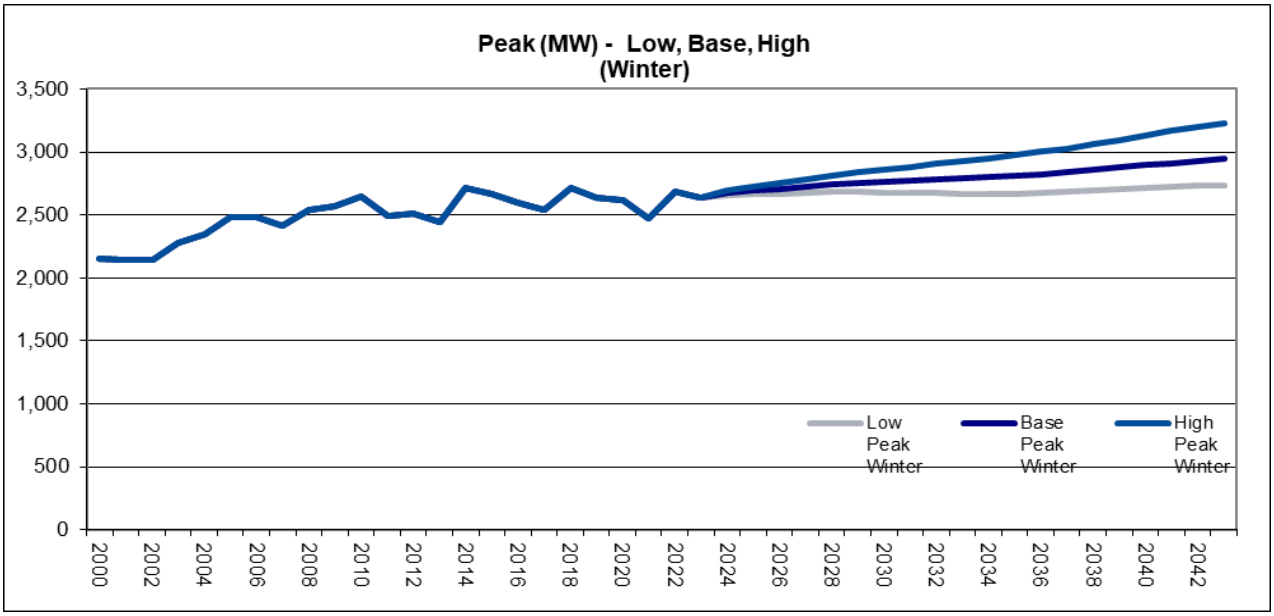


Figure 67: MO Metro Base-Case, Low-Case, and High-Case Winter Peak Demand Plots



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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 http://www.eia.gov/analysis/model-documentation.cfm

iv See regulatory_programs_mypp.pdf

v 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.htm l

vi https://www.regulations.gov/document?D=EERE-2014-BT-STD-0048-0102